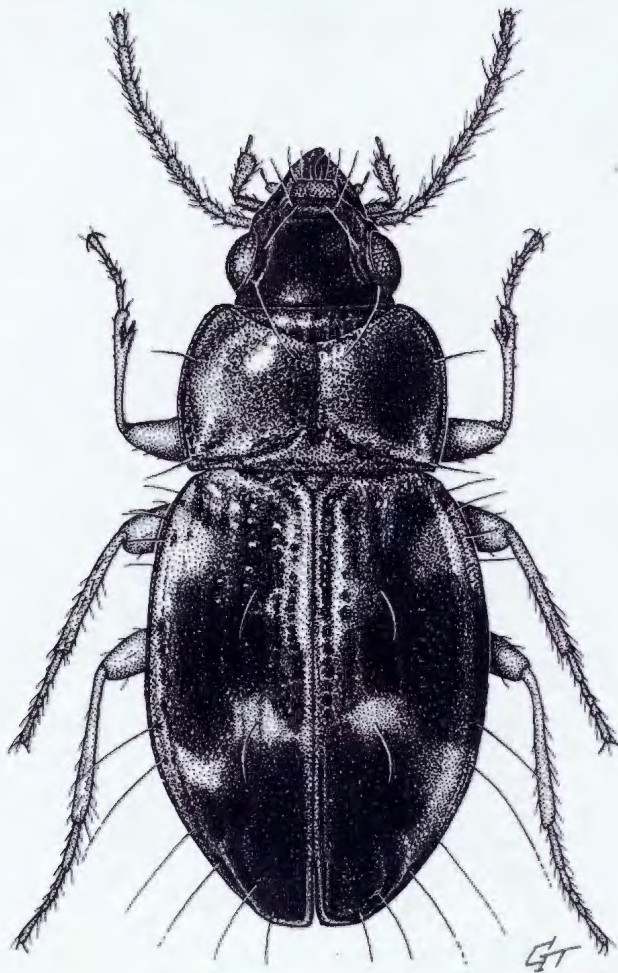


MEMOIRS

OF THE

QUEENSLAND MUSEUM



BRISBANE
1 DECEMBER 1995

VOLUME 38
PART 2



REVISION OF *PHILIPIS* (COLEOPTERA: CARABIDAE: BEMBIDIINAE), A GENUS OF ARBOREAL TACHYINE BEETLES FROM THE RAINFORESTS OF EASTERN AUSTRALIA: TAXONOMY, PHYLOGENY AND BIOGEOGRAPHY

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Baehr, M. 1995 12 01: Revision of *Philipis* (Coleoptera: Carabidae: Bembidiinae), a genus of arboreal tachyine beetles from the rainforests of eastern Australia. Taxonomy, phylogeny and biogeography. *Memoirs of the Queensland Museum* 38(2): 315-381. Brisbane, ISSN 0079-8835.

Philipis Erwin, 1994 was erected for the unique *Tachys trunci* Darlington. Extensive fogging activities in montane rainforests of eastern Queensland produced rich material and the following new species of *Philipis* are described: *agnicapitis*, *alticola*, *alutacea*, *atra*, *bicolor*, *castanea*, *cooki*, *distinguenda*, *elliotti*, *frerei*, *geoffreyi*, *heatherae*, *inermis*, *laevigata*, *laevis*, *lustrans*, *minor*, *perstriata*, *picea*, *picta*, *planicola*, *quadraticollis*, *reticulata*, *rufescens*, *ruficollis*, *sinuata*, *spurgeoni*, *striata*, *subtropica*, *sulcata*, *thompsoni*, *tribulationis*, *unicolor*, and *vicina*. *Philipis* is redefined and described, with *P. trunci* Darlington redescribed. Almost all species occur in montane rainforest above 900m, generally in moss on tree trunks. The genus occupies the Great Dividing Range in eastern Queensland from the Queensland/New South Wales border to Mt. Finnigan south of Cooktown, with most species in northeastern Queensland. Many species occur on single mountain tops or tablelands, fewer inhabit adjacent uplands, and extremely few species have a wide range or occur on two distant ranges. The Carbine Tableland and the Bellenden Ker Range east of Atherton Tableland are centres of evolution and of species richness. From there the isolated mountain tops of Mt. Finnigan and Thornton Peak in the north, and the higher tops along the east coast in the south have been colonized. According to patterns of distribution and phylogenetic evidence the history of the genus is hypothesized: *Philipis* may be a part of the so-called "Old Gondwanan element" in Australia, with its nearest relatives perhaps the South American *Xystosomus* lineage. High species diversity, however, may be a recent event: caused by uplift of the Great Dividing Range during Pliocene and Pleistocene and its subsequent disintegration into isolated tops and tablelands due to rapid erosion, and also disintegration of former widespread rainforests as a consequence of the increasingly warmer and drier climate during late Tertiary. These events divided the ranges of formerly widespread species and supported allopatric speciation on single mountain tops or ranges. Superimposed on this gradual climatic change were other radical changes during Pleistocene that caused the rainforest to repeatedly retreat up the mountains and then descend again. In that way populations of *Philipis* were repeatedly divided then rejoined, eventually becoming split into the many closely related species. According to phylogenetic evidence, the present 35 species can be thus referred to only 5 original stocks, representatives of which occur in both centres of evolution. □ *Coleoptera*, *Carabidae*, *Bembidiinae*, *Philipis*, *phylogeny*, *biogeography*.

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Australian tachyine beetles (*Tachys* sensu lato in the sense of Sloane, 1921) are not very numerous (currently about 75 species are known), but are very diverse. Hence, some of Sloane's species groups have been since included in other genera, e.g. *Pericompsus* Schaum (Erwin, 1974a), *Tachyta* Kirby (Erwin, 1975; Baehr, 1986), *Elaphropus* Motschulsky (including *Tachyura* Motschulsky, *Sphaerotachys* Müller, and the *politus*-group of Andrewes, 1925) (Erwin, 1974b; Baehr, 1987), or have been given even the rank of a new genus, e.g. *Tasmanitachoides* Erwin (Erwin, 1972; Baehr, 1990a). Apart from several species not yet revised but easily referred

to the well known genera *Tachys* Stephens sensu stricto, *Paratachys* Casey (including *Eotachys* Jeannel), and *Polyderis* Motschulsky, there still remain other isolated species or small groups of species of unknown relationships that are at present best ranked as unspecified species-groups, e.g. *ectromoides*-group (Darlington, 1962; Baehr, 1989; 1991), *atridermis*-group (*Tachys atridermis* Sloane, ? *T. carinatus* Sloane), *mitchelli*-group (*T. mitchelli* Sloane), *mulwalensis*-group (*T. mulwalensis* Sloane), *blackburni*-group (*T. blackburni* Sloane), and *trunci*-group (*T. trunci* Darlington).

Although the habits of the Australian species of *Pericompsus*, *Tasmanitachoides*, *Elaphropus*, *Tachyta*, *Tachys*, *Paratachys*, and *Polyderis* are generally known, little is known of the isolated species groups or species mentioned above. It is known that some species of the *ectromoides*-group live in leaf litter of temperate rainforest, others under bark of eucalypts, others on mossy trunks of rainforest trees (Darlington, 1962; Baehr, 1989; 1991), and the unique specimen of *Tachys trunci* was also found on the trunk of a tree in montane rainforest (Darlington, 1963).

While looking for additional material for a review of *Elaphropus* (Baehr, 1987) in the ANIC, Canberra, I found three specimens of a species from the Lamington Plateau in southern Queensland that I was unable to identify at the first glance and that later appeared not to belong to the genus *Elaphropus*. Geoff Monteith, Queensland Museum, informed me that he had found several small tachyine species on mountain tops in North Queensland by means of pyrethrum knockdown on the mossy trunks of rainforest trees. He asked me to identify his specimens and sent me a lot of specimens which turned out to belong to the same genus as those from Lamington Plateau. Since the occurrence of another, numerous, group of arboreal tachyine beetles in eastern Australia neither related to *Tachyta* nor to the *Tachys ectromoides*-group was unexpected, I began work on these specimens, because it would raise most interesting questions as to origin and relationships of this group, the phylogenetic relations of the many included species, and their biogeographic history. However, the work was set aside until more material was available. Now enough material has been accumulated to work on this group, even though additional new species may come to light on as yet unworked mountain tops.

Detailed study of the description and later the type specimen of *Tachys trunci* Darlington revealed that this species belongs to the mentioned group and is conspecific with one of the species collected by Geoff Monteith on Thornton Peak, the type locality of *T. trunci*.

Study of all available species revealed several character states common to all species. Some are apparently very primitive, the phylogenetic state of others is still obscure, but they are rather unusual in Tachyini. In some phylogenetically relevant characters (e. g. the truncate anterior tibia, the lateral position of the apical striole, the elongate terminal palpomere of both palpi), as well as in certain characteristics of shape and habitus, this new genus is very similar to the South Amer-

ican genus *Xystosomus* Schaum (Erwin, 1973) and its allies (Erwin, 1994) which include at least some arboreal or semiarboreal species (Erwin, 1973; 1974b, 1994).

Erwin (1994) redefined the *Xystosomus*-lineage and during his study, reexamined the type specimen of *Tachys trunci* Darlington and erected *Philipis* to accommodate it. Due to his very limited material, Erwin's generic concept is, unfortunately, rather limited and the diagnosis given in his key proves true only for *Philipis trunci* and a few other species. Moreover, Erwin's key does not permit unequivocal differentiation of *Philipis* from the American *Mioptachys*. I had no opportunity to study *Mioptachys* in detail, therefore I am not prepared to give a well founded differentiation of both genera at present.

MEASUREMENTS

Measurements were made with a stereo microscope using an ocular micrometer. Length was measured from tip of labrum to apex of elytra, hence these measurements may slightly differ from those made by other authors. Length of elytra was measured from humeral tooth to apex, length of pronotum from anterior angle to middle of basis, width of apex of pronotum between the position where the anterior transverse sulcus meets the anterior border, and width of head including eyes.

ABBREVIATIONS

Institutions: ANIC- Australian National Insect Collection, Canberra; CBM- Collection M. Baehr, München; MCZ- Museum of Comparative Zoology, Cambridge, Massachusetts; MDPI- Queensland Department of Primary Industries, Mareeba; QM- Queensland Museum, Brisbane; USNM- United States National Museum, Washington, D. C.; ZSM- Zoologische Staatssammlung, München.

Collectors: AG- Alistair Graham; DC- Doug Cook; DY- David Yeates; ES- Evan Schmidt; EW- Earthwatch; GM- Geoff Monteith; GT- Geoff Thompson; HJ- Heather Janetzki; JF- John Lawrence; LR- Lewis Roberts; QM- Queensland Museum; RS- Rae Sheridan; SH- Simon Hamlet; SM- Sybil Monteith; TW- Tom Weir.

RF- rainforest; Pyr.- Pyrethrum knockdown.

COLLECTING METHODS

Almost all material considered in this revision has been collected by G. Monteith and his co-workers at the Queensland Museum. Altogether 486 specimens have been examined. Because the

method used for the collection of almost all specimens is not generally known, a description of the method is provided here by Geoff Monteith:

Sheets of light nylon fabric about 1.5m square are laid flat on the ground beneath any vertical surfaces which can be found. These are mostly the trunks of standing trees, both dead and alive, but other surfaces such as large logs, stumps, boulders, rock faces and earth banks are also utilized. The vertical surfaces are then sprayed with cans of household pyrethrum aerosol insecticide. Small insects on the surfaces, which are usually densely mossy, fall on to the fabric sheets. After about 30 minutes the sheets are carefully picked up and the insects shaken into a suspended fabric funnel with a jar of alcohol attached. The bulk sample thus obtained is later sorted under the microscope. Fig. 1 shows the technique being used in a north Queensland rainforest.

CHARACTERS

The main characters for the distinction of species are shape of pronotum and elytra, colour and pattern, degree of elytral striation, degree of microreticulation of head, pronotum, and elytra, and the male genitalia, especially shape of aedeagus and its apex, structure of the sclerites in the internal sac, and shape of parameres and number and position of their apical setae.

TAXONOMIC PRINCIPLES

Many of the species mentioned herein are very closely related and most of them belong to rather well defined species groups. Only a few species bear striking autapomorphic features. Although many species possess fully developed wings, in general they seem to be restricted to single mountain formations; with very few widespread species. Since most species groups have populations dispersed over diverse mountain tops or ranges and hence the species are allopatric, they could be described as groups of allopatric subspecies. However, because the definition of subspecies is principally more crucial than the definition of species, I generally prefer to describe species rather than subspecies, when the differences in external and/or genitalic characters are constant, even when they are rather feeble.

PHYLOGENETIC PRINCIPLES

In establishing phylogenetic relationships I follow principles proposed by Hennig (1966) and initially adopted by Brundin (1966). I did not choose the quantitative phyletic approach (perhaps better called "numerical cladistic") which

chiefly proceeds according to the principle of parsimony because character analysis must be the prior condition to the construction of a phylogenetic tree and the criterion of parsimony to be used posteriorly to character analysis. Parsimony may be perhaps not as important when tracing phylogeny as most proponents believe. Evolution of species does not necessarily proceed according to that criterion, but commonly proceeds in a circuitous way in which case application of the principle of parsimony may easily generate fictitious results.

Although speciation occurs according to the rules of the biological species concept, in insects at least, its observation under natural conditions is rarely possible. Hence characters are needed as a means for distinguishing species. Although morphological structures are most widely used, other characters may be of the same value, e.g. physiological, etho-ecological, cytological, or genetical. But even genetics yield only characters and hence do not solve the problem of applying the biological species concept to recognizing species.

Reconstruction of the phylogeny and history of the fauna or of a given superspecific taxon is primarily based on the acquisition of adaptations (i.e. characters), therefore analysis of the ancestral or derivative status of characters is generally the only way to reconstruct phylogeny. As Hennig (1966) demonstrated, only derivative (apomorphic) character states are useful in such phylogenetic classification, because they alone define monophyletic groups and can be used to establish sister group relations.

As a first step towards a phylogenetic classification and analysis of faunal history the attempt is made to determine the state of the characters used. Character analysis, i.e. decision about plesiomorphy and apomorphy of characters, is based either on outgroup comparison using character states found in related taxa of higher categories as explained by Wiley (1981) and Watrous & Wheeler (1981), or on group trends as explained by Ross (1974). The latter method was used especially in such cases, when strictly synapomorphic states were difficult to perceive because of parallelisms or reductions of characters. So it will be noted in the phylogenetic analysis that only common evolutionary trends can be traced, rather than well founded sister group relations.

BIOGEOGRAPHIC PRINCIPLES

Knowledge of the phylogenetic relations of the species is prerequisite for any considerations about historical biogeography. Indeed, I do not trust the unweighed clues to geographical history used by Darlington (1957, 1971) and repeated by Erwin (1970). Hence, in general, I follow the considerations of Hennig (1966) and Brundin (1966) in that plesiomorphy of a taxon and its geographic origin are commonly correlated, that the most apomorphic taxa are therefore usually found at the margins of the range of the supra-specific taxon, and that this pattern of distribution is mainly caused by vicariance biogeography and commonly reflects a continuous distribution on old land masses or in continuous biota that are today dismembered. However, in some instances it may be caused by dispersal biogeography, e.g. when new areas are colonized and later separated by geographical or ecological barriers.

SYSTEMATICS

Subfamily BEMBIDIINAE
Subtribe XYSTOSOMINA

Philipis Erwin, 1994: 567

TYPE SPECIES

Tachys trunci Darlington, 1963, by monotypy.

NOTE

Erwin's description of *Philipis* was based on the single species *Tachys trunci* and actually only on the male holotype and on two females from G. Monteith's material sent to him for examination. Therefore his generic diagnosis and description are both of limited value and a full redescription of the genus is given below. Unfortunately the characters for keying out the genus *Philipis* used by Erwin (1994) in his key to the genera of the subtribe Xystosomina are incidental characters of *P. trunci* and do not allow the determination of the genus for most species now known. I am not familiar enough with the Neotropical taxa, especially *Mioptachys* Bates, to allow the proposal of a generic key to replace Erwin's and thus the genus *Philipis* remains recognisable only on characters of distribution.

DIAGNOSIS

Facial sulci deep, anteriorly more or less distinctly doubled, reaching clypeus; terminal palpomere of both palpi very elongate; anterior transverse sulcus of pronotum distinct and usu-

ally deep; apex of protibia almost truncate, laterally at most slightly oblique; sutural stria deeply impressed and anteriorly recurved; apical striae nearer to lateral border than to suture, incurved anteriorly and meeting 3rd stria or its position; 3rd stria with 2 discal setae and one seta within the apical striae; aedeagus moderately elongate with widely rounded apex, a complexly folded sclerite inside internal sac, apex of internal sac microtrichiate; parameres triangular, mostly 5-setose, rarely 4-setose; female stylomere 2 ensiform, rather short, with two stout ventral ensiform setae, a large dorsal ensiform seta situated rather basally, and a nematiform seta originating in a groove near apex.

The genus includes *Philipis trunci* (Darlington) and 34 new species described below.

DESCRIPTION

Small (1.8-2.8 mm long), either fairly elongate and moderately depressed, or rather short and convex species.

Colour black, or piceous, or reddish, with or without a light elytral pattern consisting of a spot or a transverse or oblique fascia in posterior third, commonly also with a more or less distinct humeral spot or fascia. In some species pronotum red. Usually 1st-3rd antennomeres and basal half of 4th antennomere of antenna yellow, rest dark. Palpi and mouth parts yellow or partly infusate. Lower surface reddish, brown, anteriorly commonly slightly darker. Legs yellow or partly infusate.

Head short and compact. Eyes large. Neck wide. Frons and vertex convex. Clypeus separated from frons by shallow suture; frons usually with shallow circular groove in middle, commonly also with circular or oblique groove medially of facial sulci. Labrum short, 6-setose. Mandibles elongate, at apex incurved. Mentum with prominent tooth, bisetose, with two deep, though not perforate foveae. Gula bisetose. Glossa narrow, rather triangular at apex, 3- or 5-setose, with the longest seta in middle; paraglossa membranous, elongate, as long as glossa or nearly so. Lacinia elongate, apex incurved, inner margin with a series of strong, elongate bristles. Penultimate palpomere of labial palpus short, globose, pilose, apical palpomere thin, remarkably elongate, usually almost as long as penultimate palpomere. Maxillary palpus rather elongate, pilose, apical palpomere thin, very elongate. Antenna rather short, sparsely pilose from 2nd antennomere, densely pilose from apical half of 4th antennomere. Median an-



FIG. 1. Queensland Museum staff using the technique of pyrethrum knockdown in a North Queensland rainforest. A, Nylon sheet spread on ground at base of tree while trunk is sprayed with aerosol pyrethrum. B, Fallen insects on sheets are then shaken into a suspended funnel with alcohol jar attached.

tennomeres globose or up to twice as long as wide.

Pronotum much wider than head. Base usually much wider than apex; anterior angle rounded off, not or barely projecting; lateral margins near base but slightly convex or almost straight; posterior angle usually about rectangular, commonly posteriorly slightly projecting. Anterior transverse sulcus always distinct, usually deep, v-shaped, impunctate. Median line distinct, though usually fine, not reaching base. Posterior transverse sulcus deep, impunctate, commonly interrupted in middle by a deep fovea. Lateral channel deep and rather wide, posteriorly more or less widened; with two lateral setae, the anterior seta situated at or behind anterior third, the posterior at basal angle. Basal grooves deep, laterally bordered by a conspicuous, elongate, usually straight to slightly oblique carina. Prosternum with sparse, erect pilosity.

Elytra fairly elongate and depressed, or more or less convex and short. When elytra depressed,

then commonly with a distinct transverse impression in anterior third, sometimes each elytron with a large, circular impression behind middle. Lateral channel deep and wide. Lateral margin commonly finely serrate and pilose. Sutural stria always deeply impressed and anteriorly curved towards scutellar pore. 2nd-7th striae present or reduced to various degrees, or all or some striae indicated as rows of punctures, or deeply channelled, or completely absent. 8th stria present, usually attaining at least the posterior pore of the anterior group of marginal pores, rarely ending shortly behind this pore; usually deeply impressed, commonly punctate-crenulate. Apical stria situated rather close to lateral border, but anteriorly more or less incurved to meet the end of the 3rd stria or its position; stria usually deep, deepened at the position of incurvation. 3rd stria with two discal pores and setae at about anterior third and behind middle, and with a pore and seta within the apical stria. Marginal pores large, setae not very elongate, but usually markedly

different, anterior group consisting of 4, posterior group of 2 + 2 pores, separated by a wide glabrous space. Wings fully developed or more or less reduced. Prosternum with few erect hairs. Metepisternum almost quadrate to c. 1.5 x as long as wide at apex.

Abdomen smooth, impilose, each sternite with a pair of ambulatory setae, last visible sternite in males with 2, in females with 4 setae near border in a transverse row.

Legs normal shaped, apex of protibia truncate, lateral border not at all excised. Two basal tarsomeres of male protarsus slightly asymmetrically widened and clothed with adhesive setae. Claws large, elongate, not serrate.

Microreticulation on head usually rather coarse, isodiametric, though commonly reduced and more or less superficial on frons and vertex, but still present on labrum, clypeus and near lateral margin. Pronotum with or without isodiametric microreticulation. Elytra with distinct or superficial microreticulation, or without any microreticulation. Microreticulation usually transverse, rarely almost isodiametric. Sometimes intervals with very sparse, extremely fine puncturation.

Male genital ring triangular, feebly asymmetric. Aedeagus variously shaped, with asymmetrical basal lobe and usually short, convex apex. Internal sac in middle with complexly coiled sclerites. Apex of internal sac with a densely trichose or spinose field. Parameres with 4 or 5 apical or subapical setae, left paramere larger than right.

Female stylomere 2 ensiform, with 2 strong ventral ensiform setae, 1 dorsal ensiform seta situated rather basally, and a nematiform seta originating in a groove. Shape of stylomeres highly uniform throughout the genus.

DISTRIBUTION

Rainforests of eastern Queensland from the Queensland/New South Wales border north to about Cooktown, though most species on the eastern fringes of the Atherton and Carbine Tablelands in north Queensland.

HABITAT

Almost all specimens collected by pyrethrum knockdown from mossy tree trunks of rainforest trees; a few were from Berlese extraction of moss and litter. They occur with few exceptions on high mountain tops above c. 900m.

KEY TO THE SPECIES OF THE GENUS *PHILIPIS* ERWIN

Because many species are apparently restricted to a single range or even to one mountain top, and perhaps even to a narrow altitude range, the known range of the species is generally recorded in the key. It should be noted, however, that the recorded geographic and altitudinal ranges may change due to additional collecting work. So distribution should not be used as a *prima facie* character for determination.

1. Elytra without distinct colour pattern 2
Elytra with distinct colour pattern, each elytron unimaculate or bimaculate, or fasciate 5
2. Rather short, dorsally convex species, lateral borders of pronotum convex throughout, though sometimes irregularly convex. Aedeagus as in Figs 4D-E. Bellenden Ker Range, and mountains near Eungella, northwest of Mackay . . . 3
Rather elongate and depressed species, lateral borders of pronotum in posterior half straight or even faintly concave, though sometimes slightly oblique. Aedeagus as in Fig. 4C or unknown. Mountains near Mossman and near Cape Tribulation 4
3. Smaller, shorter species, body length <2.25mm, ratio length/width of elytra <1.3. Colour piceous. Lateral margin of pronotum evenly rounded, basal angle slightly produced backwards. Aedeagus, Fig. 4D. Bellenden Ker and Malbon Thompson Ranges, between 900-1450m *unicolor* sp. nov.
Larger, more elongate species, body length 2.40mm, ratio length/width of elytra 1.37. Colour black. Lateral margin of pronotum irregularly rounded, compressed in basal half, basal angle not produced backwards. Aedeagus, Fig. 4E. Mt. Macartney north of Eungella, northwest of Mackay *atra* sp. nov.
4. Lateral borders of pronotum faintly concave, pronotum at base as wide as in middle. At least 5 inner striae well visible. Aedeagus unknown. Mossman Bluff at c.850m *picea* sp. nov.
Lateral borders of pronotum straight, pronotum at base narrower than in middle. Only 2 inner striae well visible, others very faint. Aedeagus, Fig. 4C. Thornton Peak and mountains west of Cape Tribulation above c.750m *castanea* sp. nov.
5. Elongate, depressed species, elytra only with postmedian fascia 6
Short, convex species, pattern of elytra variable 12
6. Elytra without distinct transverse impression in anterior third (doubtful species under both couplets) 7

- Elytra with distinct impression in anterior third 9
7. At least 4 inner intervals of elytra distinctly convex in anterior half. Large species, body length >2.7mm. Pronotum in middle barely wider than at base. Aedeagus unknown. Mountains north-west of Mossman, Massey Range west of Bellenden Ker Range, between 1000-1200m *quadraticollis* sp. nov.
- Only 2 inner intervals of elytra distinctly convex in anterior half. Smaller species, body length <2.35mm. Pronotum variable. Aedeagus, Fig. 4B or unknown 8
8. Pronotum in middle perceptibly wider than at base. Smaller species, body length <2.25mm. 2 inner intervals of elytra distinctly convex. Lower surface of aedeagus straight, Fig. 4B. Mt. Spurgeon above 1100m *laevigata* sp. nov.
- Pronotum in middle barely wider than at base. Larger species, body length c. 2.35mm. Only sutural interval of elytra distinctly convex. Aedeagus unknown. Isley Hills south of Cairns *heatherae* sp. nov.
9. Pronotum in middle barely wider than at base, ratio widest part/base <1.04. Postmedian elytral fascia not s-shaped. Mountains east of Atherton Tableland 10
- Pronotum in middle distinctly wider than at base, ratio widest part/base >1.07. Postmedian elytral fascia more or less distinctly s-shaped. Mountains west of Mossman 11
10. Large species, body length >2.7mm. Colour dark reddish. Transverse impression in anterior third of elytra deep. 2nd stria distinctly impressed, 3rd-5th striae distinct. Aedeagus unknown. Bellenden Ker Range at 1560m *alticola* sp. nov.
- Smaller species, body length c. 2.35mm. Colour dark piceous. Transverse impression in anterior third of elytra shallow. 2nd stria barely impressed, 3rd-5th striae very weak. Aedeagus unknown. Isley Hills south of Cairns *heatherae* sp. nov.
11. Larger species, body length >2.35mm. Pronotum wider, base wider, ratio base/apex >1.45. Aedeagus longer with narrower apex, both parameres 4-setose, Fig. 4A. Mountains immediately west of Mossman above 1000m *cooki* sp. nov.
- Smaller species, body length <2.25mm. Pronotum narrower, base narrower, ratio base/apex <1.40. Aedeagus shorter with wider apex, both parameres 5-setose, Fig. 4B. Mt. Spurgeon at 1100m *laevigata* sp. nov.
12. Elytra unimaculate or -fasciate 13
- Elytra distinctly bimaculate or -fasciate (doubtful species under both couplets) 22
13. Elytra with circular or slightly transverse macula or fascia (Figs 12D-E). Pronotum reddish or pronotum remarkably narrow, ratio width/length <1.35, with narrow base, ratio base/apex <1.35. Elytra rather elongate, ratio length/width >1.35. Aedeagus as in Figs 4F, 5A. Mt. Finnigan 14
- Elytra with conspicuously s-shaped, oblique fascia (Figs 12F, 13B-D). Pronotum not reddish and pronotum wider, ratio width/length >1.40, with wider base, ratio base/apex >1.38. Elytra shorter, ratio length/width <1.35. Aedeagus as in Figs 5B-F, 6A. Distribution further south 15
14. Larger species, body length >2.3mm. Pronotum reddish, wider, ratio width/length >1.40, with wider base, ratio base/apex >1.45. Aedeagus, Fig. 4F. Above 850m *ruficollis* sp. nov.
- Smaller species, body length <2mm. Pronotum dark piceous to black, narrower, ratio width/length <1.35, with narrow base, ratio base/apex <1.35. Aedeagus, Fig. 5A. Above 1100m *inermis* sp. nov.
15. Lateral borders of pronotum in posterior half straight, base as wide as or even wider than widest diameter in middle. Lower surface of aedeagus almost straight, apex not perceptibly curved down (Fig. 5C). Eastern foothills of Bellenden Ker Range below 100m *planicola* sp. nov.
- Lateral borders of pronotum in posterior half perceptibly convex, base distinctly narrower than widest diameter in middle. Lower surface of aedeagus either concave or apical third curved down (Figs 5B, 5D-F, 6A). Distribution different or upland species 16
16. 5th-7th intervals not perceptibly weaker than inner intervals 17
- 5th-7th intervals markedly weaker than inner intervals, or absent 18
17. Striae not impressed, intervals not convex. Microreticulation of elytra weak, surface glossy. Base of pronotum wider, ratio base/apex >1.5. Aedeagus, Fig. 5B. Cape Tribulation below 150m *striata* sp. nov.
- Striae in basal half slightly impressed, intervals perceptibly convex. Microreticulation of elytra distinct, surface rather dull. Base of pronotum less wide, ratio base/apex 1.45. Aedeagus unknown. Bellenden Ker Range at 1000m *reticulata* sp. nov.
18. 1st and 2nd striae equally deeply impressed, 3rd-5th striae very inconspicuous or absent. Aedeagus shorter (Fig. 5D). Thomson Peak above 900m *trunci* (Darlington)
- 2nd stria distinctly less deeply impressed than 1st, or not impressed, 3rd-5th striae visible as rows of punctures. Aedeagus longer (Figs 5E-F, 6A). Distribution different 19

19. Smaller species, body length <2.15mm, and base of pronotum rather narrow, ratio base/apex <1.42. Aedeagus, Fig. 5E. Mountains west of Cape Tribulation and Windsor Tableland above 700m *tribulationis* sp. nov.
Commonly larger species, body length >2.20mm, or base of pronotum wider, ratio base/apex >1.45. Aedeagus as in Figs 5F, 6A. Distribution different 20
20. Aedeagus shorter, with shorter apex and lower surface not perceptibly bisinuate (Fig. 5F) and surface of elytra without distinct microreticulation and outer striae very fine and base of pronotum wider, ratio base/apex >1.45. Mountains from Atherton Tableland south to Cardwell Range above 700m *thompsoni* sp. nov.
Either aedeagus longer, with longer apex and lower surface perceptibly bisinuate (Fig. 6A) or surface of elytra distinctly microreticulate or outer striae rather distinct or base of pronotum narrower, ratio base/apex <1.45. Distribution different 21
21. Microreticulation of elytra almost absent, elytra as glossy as pronotum, Aedeagus, Fig. 6A. Mt. Misery south of Helenvale above 850m *vicina* sp. nov.
Microreticulation of elytra distinct, elytra perceptibly less glossy than pronotum. Aedeagus unknown. Mt. Spurgeon area at 1330m *spurgeoni* sp. nov. 21
22. Only sutural stria of elytra present. Surface of pronotum and elytra extremely glossy, without any trace of microreticulation. Wide, highly convex species with very short elytra, ratio length/width <1.28. Aedeagus, Fig. 6B. Thornton Peak above 1000m *laevis* sp. nov.
At least traces of outer striae visible. Surface usually less glossy, at least with some traces of microreticulation. Usually less wide and convex species with longer elytra, ratio length/width >1.29, rarely less, but then elytra completely and deeply striate. Aedeagus different. Distribution different 23
23. Elytra completely striate and striae deeply impressed, outer striae not perceptibly weaker than inner, all intervals remarkably convex. Aedeagus with elongate apex and deep concavity in front of apex (Fig. 6C), or unknown 24
At least outer striae not deeply impressed, distinctly weaker than inner, often elytra not completely striate, not all intervals convex. Aedeagus different 25
24. Wider and on the average larger species, body length 2.05-2.50mm. Pronotum wider, ratio width/length >1.53, ratio base/apex >1.48. Elytra shorter, ratio length/width <1.31. Aedeagus, Fig. 6C. Mountains west of Mossman between 480-1300m *sulcata* sp. nov.
- Narrower and smaller species, body length 2.05mm. Pronotum narrower, ratio width/length 1.41, ratio base/apex 1.37. Elytra longer, ratio length/width >1.38. Aedeagus unknown. Mt. Bartle Frere above 1600m *perstriata* sp. nov.
25. Posterior elytral fascia distinctly s-shaped and basal elytral macula well delimited, triangular, meeting lateral border 26
Posterior elytral fascia variable, when s-shaped, then basal elytral macula less well delimited, often rather vague, and not meeting lateral border 29
26. Pronotum reddish, elytral pattern very distinct. At least 6 inner striae well marked, though only sutural stria impressed. Aedeagus, Fig. 7E. Mt. Demi southwest of Mossman above 1100m *bicolor* sp. nov.
Pronotum piceous, elytral pattern less distinct. At most 4 inner striae well marked and more or less impressed. Aedeagus as in Figs 7D, 7F, 8A. Distribution different 27
27. Elytra barely striate, only sutural stria distinct and impressed, other striae very indistinct. On the average larger species, body length 2.2mm. Aedeagus very short, with short apex (Fig. 7D). Mt. Finnigan above 1100m *picta* sp. nov.
Elytra more extensively striate, at least 3 inner striae distinct and somewhat impressed. On the average smaller species, body length <2.2mm. Aedeagus longer, with longer apex (Figs 7F, 8A). Distribution different 28
28. Larger and wider species, body length >2.1mm, ratio length/width of elytra <1.32, with wider pronotum, ratio width/length >1.55. Lower surface of aedeagus almost straight, apex narrower (Fig. 7F). Mt. Spurgeon area above 1250m *geoffreyi* sp. nov.
Smaller and narrower species, body length 2mm, ratio length/width of elytra 1.35, with narrower pronotum, ratio width/length <1.5. Lower surface of aedeagus distinctly bisinuate, apex wider (Fig. 8A). Mossman Bluff west of Mossman at 1180m *minor* sp. nov.
29. Posterior fascia distinctly s-shaped 30
Posterior fascia not distinctly s-shaped (doubtful species under both couplets) 33
30. Larger species, body length >2.6mm 31
Smaller species, body length <2.5mm 32
31. Wider species, ratio length/width of elytra <1.36, with wider pronotum, ratio width/length >1.5, ratio base/apex >1.5. Lower surface of aedeagus gently concave (Fig. 8B). Bellenden Ker Range above 1500m *sinuata* sp. nov.
Narrower species, ratio length/width of elytra >1.38, with narrower pronotum, ratio width/length <1.48, ratio base/apex <1.48. Lower surface of aedeagus gently bisinuate

- (Fig. 8C). Mossman Bluff west of Mossman between 480-1200m . . . *distinguenda* sp. nov.
32. More or less reddish species, but at least pronotum somewhat reddish. Pronotum and elytra strongly microreticulate. Posterior elytral fascia rather weakly s-shaped (Fig. 15A). Aedeagus longer, lower surface gently concave, parameres 4-setose (Fig. 7A). Bellenden Ker Range above 1500m *rufescens* sp. nov.
 Piccous species, pronotum not reddish. Pronotum and elytra glossy, almost devoid of microreticulation. Posterior elytral fascia markedly s-shaped (Fig. 16E). Aedeagus short, compact, lower surface bisinuate, parameres 5-setose (Fig. 8D). Bellenden Ker Range and Lambs Head, between 900-1200m *lustrans* sp. nov.
33. Pronotum remarkably wide at base, ratio base/apex >1.6, ratio widest diameter/base <1.06. Microreticulation of elytra isodiametric, surface rather dull. Lower surface of aedeagus markedly bisinuate, apex very wide (Fig. 6F). Bellenden Ker above 1500m . . . *alutacea* sp. nov.
 Pronotum less wide at base, ratio base/apex <1.5, ratio widest diameter/base >1.10. Microreticulation of elytra transverse, surface less dull. Aedeagus different (Figs 6D-E, 7A-C) 34
34. Pronotum and elytra strongly microreticulate. Lateral borders of pronotum posteriorly not convex, though oblique. Posterior elytral fascia oblique, feebly s-shaped (Fig. 15A). Aedeagus, Fig. 7A. Bellenden Ker Range above 1500m *rufescens* sp. nov.
 Microreticulation of pronotum and elytra weaker or absent. Lateral borders of pronotum posteriorly usually perceptibly convex, when straight, then posterior elytral fascia transverse. Posterior fascia transverse or oblique, but not at all s-shaped (Figs 14D-E, 15C-E). Aedeagus as in Figs 6D-E, 7B-C. Distribution different 35
35. Only sutural stria impressed. On average larger species, body length 2.3-2.8mm. Posterior elytral fascia transverse. Aedeagus with elongate, wide apex and a strongly sclerotized peg in internal sac (Fig. 6E). Lamington Plateau, south Queensland, above 1000m *subtropica* sp. nov.
 Additional striae perceptibly impressed. On average smaller species, body length 1.85-2.45mm. When larger than 2.3mm, then inner 3-4 striae markedly impressed and posterior elytral fascia oblique. Aedeagus different (Figs 6D, 7B-C), north Queensland 36
36. Posterior elytral fascia oblique (Fig. 14D). On average larger species, body length 2.05-2.45mm, with wider pronotum, ratio width/length >1.6. 3-4 inner striae conspicuously impressed and feebly punctate. Aedeagus, Fig. 6D. Mt. Bartle Frere above 1500m *freiei* sp. nov.
 Posterior elytral fascia rather transverse (Figs 17C-D). On average smaller species, body length 1.85-2.3mm, with narrower pronotum, ratio width/length <1.57. Inner striae less conspicuously depressed, but distinctly punctate. Aedeagus as in Figs 7B-C. Distribution different 37
37. Elytra slightly darker, hence pattern more contrasting. Lateral border of pronotum usually less convex in posterior half, base wider, ratio base/apex <1.38. Aedeagus narrower, with larger apex, parameres with 4, rarely left paramere with 5 setae (Fig. 7B). Mt. Elliot above 1000m *elliotti* sp. nov.
 Elytra slightly lighter, hence pattern less contrasting. Lateral border of pronotum usually rather convex in posterior half, base narrower, ratio base/apex <1.37. Aedeagus wider, with smaller apex, both parameres always 5-setose (Fig. 7C). Lambs Head near Edmonton, at 1200m *agnicapitis* sp. nov.

NOTE

In the following descriptions only those characters are mentioned in detail that are distinctive for the respective species.

Phillipis quadraticollis sp. nov.
(Figs 11A, 16F, 17C)

MATERIAL EXAMINED

HOLOTYPE: QMT13508; ♀, Devils Thumb area 10km NW Mossman, NEQ, 10 Oct 1982, 1000-1180m, Monteith, Yeates & Thompson, Pyrethrum knockdown, RF.

PARATYPE: 1 ♀, 17°14'S x 145°48'E Massey Rd., 6km NW of Bellenden Ker, NEQ, 1150m, 11 Oct 1991, Pyr., GM & HJ (CBM)

DIAGNOSIS

Large, depressed, with an oblique fascia in posterior half of elytra. Distinguished by absence of transverse impression in anterior third of elytra, large size, and convex four inner intervals of elytra.

DESCRIPTION

Measurements. Length: 2.7-2.8mm; width: 1.20-1.25mm. Ratios: Width pronotum/head: 1.48-1.49; width/length of pronotum: 1.55-1.58; width base/apex of pronotum: 1.57-1.60; width widest diameter/base of pronotum: 0.99; length/width of elytra: 1.43.

Colour. Chestnut brown, head slightly darker. Sutural interval lighter posteriorly. Elytra in posterior 2/5 with an oblique, at medial end strongly recurrent yellow fascia not attaining suture.

Head. Median antennomeres c. 1.2 x as long as wide. Microreticulation on frons distinct, though somewhat superficial, isodiametric, on vertex less distinct. Surface moderately glossy, on vertex rather glossy.

Pronotum. Fairly depressed, transverse, widest near base, base much wider than apex. Lateral margin anteriorly strongly rounded, posteriorly straight. Posterior angle rectangular, faintly produced over lateral part of base. Carina at posterior angle elongate, oblique, slightly incurved. Anterior transverse sulcus comparatively shallow, uninterrupted in middle. Posterior transverse sulcus slightly interrupted in middle. Anterior lateral seta situated slightly behind anterior third of margin. Surface almost devoid of microreticulation, with scattered, extremely fine punctures, highly glossy.

Elytra. Rather elongate, moderately convex, widest in middle; lateral border almost evenly curved, though in middle almost straight. Disk not impressed in anterior third. Sutural stria finely punctulate. 2nd-5th striae impressed, punctate, 6th and 7th striae visible as rows of fine punctures. All inner striae traceable to far down apex. Most intervals, apart from 7th and 8th, distinctly convex, at least in anterior half. 8th stria deeply impressed, punctate, attaining posterior marginal pore. Recurrent striae deep, punctulate, clearly meeting 3rd stria. Anterior discal pore in anterior third, posterior pore in posterior 2/5. Microreticulation on disk barely visible, at apex slightly more distinct, composed of transverse meshes. Surface with scattered, extremely fine punctures, highly glossy. Wings fully developed.

Lower surface. Metepisternum 1.5 x as long as wide.

Genitalia. Male unknown. Female stylomere 2 with dorsal ensiform seta situated rather basally.

Variation. Apart from some variation of relative shape of pronotum, little variation noted.

DISTRIBUTION

Mountains to the east of Atherton Tableland and to the northwest of Mossman, north Queensland.

HABITAT

Both known specimens collected by pyrethrum knockdown on mossy tree trunks in montane rainforests above 1000m.

ETYMOLOGY

Refers to the quadrate shape of pronotum.

REMARKS

Because both specimens are females, it is not fully settled, whether they are actually conspecific. Discovery of males from both localities would be very useful.

Philipis alticola sp. nov.
(Figs 11B, 17C)

MATERIAL EXAMINED

HOLOTYPE: QMT13509; ♀, Bellenden Ker summit, NEQ, 10 June 1980, G. B. Monteith.

DIAGNOSIS

Large, depressed, with oblique fascia on posterior half of elytra. Distinguished by wide base of pronotum that is almost as wide as in middle, by fascia of elytra not s-shaped, and by impressed 2nd interval and fairly distinct 3rd-5th intervals.

DESCRIPTION

Measurements. Length: 2.75mm; width: 1.24mm. Ratios: Width pronotum/head: 1.41; width/length of pronotum: 1.45; width base/apex of pronotum: 1.48; width widest diameter/base of pronotum: 1.04; length/width of elytra: 1.45.

Colour. Chestnut brown, head and lateral parts of elytra slightly darker. Sutural interval posteriorly feebly lighter. Elytra in posterior 2/5 with oblique, feebly s-shaped, at medial margin not recurrent yellow fascia not attaining suture.

Head. Median antennomeres c. 1.5 x as long as wide. Microreticulation on frons distinct, isodiametric, slightly less distinct on vertex. Surface moderately dull, more glossy on vertex.

Pronotum. Fairly depressed, transverse, widest well in front of middle, base much wider than apex. Lateral margin posteriorly almost straight, though somewhat oblique. Posterior angles rectangular, faintly produced over lateral part of base. Carina at posterior angle elongate, oblique, slightly incurved. Anterior transverse sulcus rather deep, interrupted in middle. Posterior transverse sulcus very deep, interrupted by a fovea. Anterior lateral seta situated at anterior third of margin. Surface with fairly superficial, almost isodiametric microreticulation, fairly glossy.

Elytra. Rather elongate, moderately convex, widest in middle. Lateral border almost evenly curved, though in middle almost straight. Disk in anterior third at position of anterior discal seta

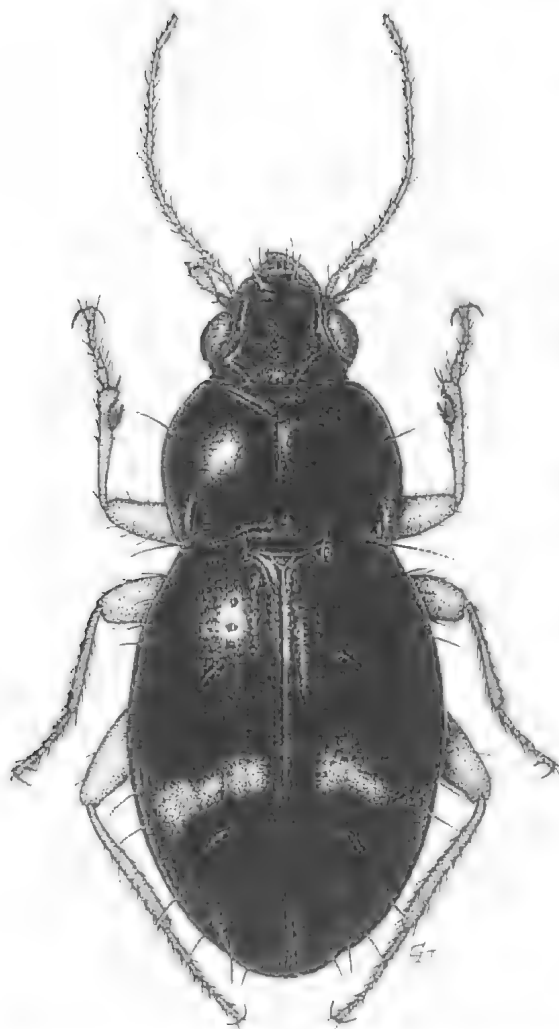


FIG. 2. Dorsal view of *Philipis thompsoni* sp. nov.

with conspicuous, rather deep depression. Sutural stria finely punctulate. 2nd stria almost completely impressed, punctate, 3rd-5th striae visible as rows of fine punctures. Outer striae only traceable in anterior half as rows of extremely fine punctures. Intervals, apart from sutural and 2nd intervals completely depressed. 8th stria deeply impressed, punctate, anteriorly shallower, not attaining posterior marginal pore. Recurrent striae elongate, oblique, meeting 3rd stria. Anterior discal pore in anterior third, posterior pore in posterior 2/5. Microreticulation distinct, though fairly superficial, composed of transverse meshes. Surface rather glossy. Wings fully developed. Variation unknown.

Lower surface. Metepisternum c. 1.5 x as long as wide.

Genitalia. Male unknown. Female stylomere 2 with dorsal ensiform seta situated rather basally.

DISTRIBUTION

Bellenden Ker Range, to the east of Atherton Tableland, north Queensland. Known only from type locality.

HABITAT

Collecting circumstances unknown. This is a high mountain species, collected above 1500m in montane rainforest in June.

ETYMOLOGY

Refers to the occurrence on the summit of Bellenden Ker.

Philipis cooki sp. nov.

(Figs 4A, 11C, 17C)

MATERIAL EXAMINED

HOLOTYPE: QMT13510; ♂, 5.5km N. of Mt. Lewis, via Julatten, NEQ, 1200m, 13 Sept 1981, G. Monteith & D. Cook.

PARATYPES: 1 ♂, 1 ♀, same data (QM); 1 ♂, 2.5km N Mt. Lewis via Julatten, NEQ, 3 Nov 1983, 1040m, DY & GT, Pyr. in RF (QM); 2 ♂, Devils Thumb area 10km NW Mossman, NEQ, 10 Oct 1982, 1000-1180m, GM, DY & GT, Pyr., RF (CBM, QM); 1 ♂, 1 ♀, Mossman Bluff Summit 10km W Mossman, NEQ, 18 Dec 1988, 1300m, GM & GT, Pyr. Trees & Rocks (QM); 1 ♂, 3 ♀, Mt. Demi, 7km SW of Mossman, NEQ, 29 Oct 1983, 1100m, DY & GT, Pyr. in RF (CBM, QM, USNM, ZSM); 4 ♂, Carbine Tableland, NEQ, Plane Crash Site, 1330m, 28 Nov 1990, GM & HJ, Pyr. - Logs & Trees (ANIC, CBM, QM).

DIAGNOSIS

Medium sized to rather large, depressed, with an oblique, s-shaped fascia in posterior half of elytra. Distinguished by distinct transverse impression in anterior third of elytra, narrower base of pronotum, distinctly s-shaped elytral fascia, and longer aedeagus with longer apex, and 4-setose parameres.

DESCRIPTION

Measurements. Length: 2.35-2.70mm; width: 1.10-1.18mm. Ratios: Width pronotum/head: 1.44-1.48; width/length of pronotum: 1.42-1.47; width base/apex of pronotum: 1.45-1.51; width widest diameter/base of pronotum: 1.07-1.09; length/width of elytra: 1.41-1.45.

Colour. Dark piceous, pronotum, base and apex of elytra and posterior part of suture faintly

lighter. Elytra in posterior 2/5 with an oblique, strongly s-shaped, at median end recurrent yellow fascia not attaining suture. Legs yellow, tibiae sometimes faintly darker.

Head. Median antennomeres c. 1.75 x as long as wide. Microreticulation very indistinct and superficial, about isodiametric, even less distinct on vertex. Surface glossy.

Pronotum. Fairly depressed, transverse, widest slightly in front of middle, base much wider than apex. Lateral margin posteriorly feebly rounded or even almost straight, though somewhat oblique. Posterior angles rectangular, faintly produced over lateral part of base. Carina at posterior angle elongate, oblique, slightly incurved. Anterior transverse sulcus rather deep, uninterrupted. Posterior transverse sulcus very deep, interrupted by a large fovea. Anterior lateral seta situated at anterior third of margin. Microreticulation extremely superficial, indistinct, slightly transverse. Surface highly glossy.

Elytra. Fairly elongate, moderately convex, reversely egg-shaped, widest about in middle. Lateral border evenly curved. Disk in anterior third at position of anterior discal seta with conspicuous, rather deep depression. Sutural stria finely punctulate. 2nd stria visible as a row of small punctures, in anterior half even faintly impressed, 3rd-5th striae anteriorly more or less well visible as indistinct rows of extremely fine punctures. Outer striae almost invisible. Intervals absolutely depressed, apart from sutural and 2nd in anterior half. 8th stria deeply impressed, punctate, posteriorly punctate-crenulate, attaining posterior marginal pore. Recurrent striae meeting position of 3rd stria. Anterior discal pore in anterior third, posterior pore posterior 2/5. Microreticulation distinct, though fairly superficial, composed of very transverse meshes, surface rather glossy. Wings fully developed.

Lower surface. Metepisternum c. 1.5 x as long as wide.

Male genitalia. Genital ring slightly asymmetrical, apex rather acute. Aedeagus elongate, rather depressed, lower surface absolutely straight. Apex short, rounded off. Internal sac in middle with two areas of microtrichia. Both parameres 4-setose seta on upper border absent.

Female genitalia. Stylomere 2 with dorsal ensiform seta situated rather basally.

Variation. Apart from minor differences in relative shape of pronotum and elytra and degree of microreticulation, little variation noted.

DISTRIBUTION

Widespread on the Carbine Tableland west of Mossman, north Queensland.

HABITAT

Rainforest on mountains tops above 1000m by pyrethrum knockdown on trees, "on trees and rocks", or "logs and trees". So far collected from September to December.

ETYMOLOGY

For Doug Cook, collector of many specimens of *Philipis*.

Philipis laevigata sp. nov.
(Figs 4B, 11D, 17C)

MATERIAL EXAMINED

HOLOTYPE: QMT13520; ♂, 2km SE Mt. Spurgeon via Mt. Carbine, NEQ, 20 Dec 1988, 1100m, Monteith & Thompson, Pyrethrum/Trees & Logs.

PARATYPE: 1 ♂, 4km NNE Mt. Spurgeon, NEQ, 15 Oct 1991, GM & HJ, QM Berlesate Nr. 855, 16°24'S, 145°13'E, RE, 1250m, Sieved litter (CBM).

DIAGNOSIS

Depressed, with an oblique fascia in posterior half of elytra. Very similar to *P. cooki*, but smaller, pronotum narrower, 2nd stria on elytra deeply impressed and 2nd interval convex, microreticulation of elytra almost absent, aedeagus shorter with larger apex, and both parameres 5-setose.

DESCRIPTION

Measurements. Length: 2.2mm; width: 1.00-1.02mm. Ratios: Width pronotum/head: 1.41-1.44; width/length of pronotum: 1.41-1.45; width base/apex of pronotum: 1.39; width widest diameter/base of pronotum: 1.09-1.11; length/width of elytra: 1.41-1.44.

Colour. Dark piceous, pronotum, base and apex of elytra and posterior part of suture faintly lighter. Elytra in posterior 2/5 with a rather inconspicuous, moderately well delimited, oblique, s-shaped, at median end recurrent yellow fascia attaining about 2nd stria.

Head. Median antennomeres c. 1.5 x as long as wide. Microreticulation rather distinct, though somewhat superficial, less distinct on vertex, about isodiametric. Surface rather glossy.

Pronotum. Fairly depressed, transverse, widest slightly in front of middle, base much wider than apex. Lateral margin posteriorly feebly rounded, though somewhat oblique. Posterior angles rectangular, faintly produced over lateral part of

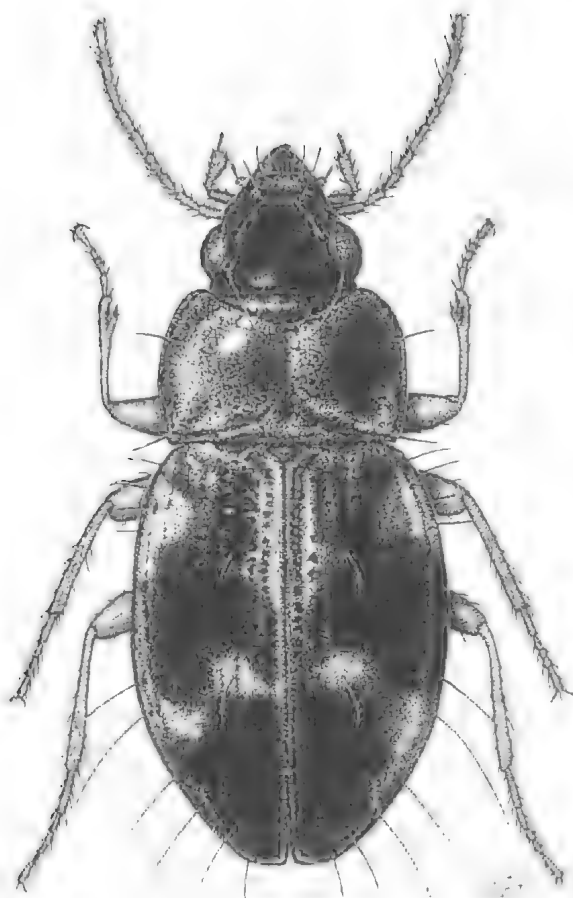


FIG. 3. Dorsal view of *Philipis bicolor* sp. nov.

base. Carina at posterior angle elongate, oblique, slightly incurved. Anterior transverse sulcus rather deep, uninterrupted. Posterior transverse sulcus very deep, interrupted by a large fovea. Anterior lateral seta situated at anterior third of margin. Microreticulation indistinct, highly superficial, slightly transverse. Surface glossy.

Elytra. Fairly elongate, moderately convex, reversely egg-shaped, widest about in middle. Lateral border evenly curved. Disk in anterior third without transverse depression. Sutural stria finely punctulate. 2nd stria apparently also rather deeply impressed (though elytra of type somewhat creased), finely punctate. 3rd-5th striae anteriorly just visible as indistinct rows of extremely fine punctures. Outer striae almost invisible. Sutural and 2nd intervals convex, outer intervals absolutely depressed. 8th stria deeply impressed throughout, almost impunctate, attaining posterior marginal pore. Recurrent striae elongate,

oblique, meeting position of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior third. Microreticulation indistinct, highly superficial, composed of irregular, very transverse meshes, surface highly glossy. Wings fully developed.

Lower surface. Metepisternum c. 1.5 x as long as wide.

Male genitalia. Genital ring asymmetrically triangular, apex rather obtuse. Aedeagus short and compact, lower surface straight. Apex short, wide, widely rounded off. Internal sac in middle with two areas of microtrichia. Both parameres 5-setose. Female genitalia unknown.

Variation. Very little variation noted.

DISTRIBUTION

Mt. Spurgeon and vicinity, Carbine Tableland, north Queensland.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks and logs and by sieving litter in montane rainforest above 1100m. Collected October and December.

ETYMOLOGY

Refers to the smooth, glossy elytra.

***Philipis heatherae* sp. nov.**
(Figs 11E, 18A)

MATERIAL EXAMINED

HOLOTYPE: QMT13521; ♀, 17°03'S x 145°42'E Isley Hills, NEQ, 1050m 30 Nov 1993 Monteith & Janetzki, Pyrethrum/trees & rocks.

DIAGNOSIS

Medium-sized, depressed, with an oblique fascia in posterior half of elytra. Distinguished by wide base of pronotum that is almost as wide as diameter of pronotum in middle, by fascia of elytra not s-shaped, and by 2nd interval not impressed and 3rd-5th intervals indistinct.

DESCRIPTION

Measurements. Length: c. 2.35mm; width: c. 1.08mm. Ratios: Width pronotum/head: 1.41; width/length of pronotum: 1.46; width base/apex of pronotum: 1.50; width widest diameter/base of pronotum: 1.03; length/width of elytra: 1.42.

Colour. Dark piceous, suture and lateral margins of elytra faintly lighter. Elytra in posterior 2/5 with a moderately conspicuous, fairly well delimited, oblique, faintly s-shaped, at median

end recurrent yellow fascia attaining about 2nd stria.

Head. Median antennomeres c. 1.5 x as long as wide. Microreticulation rather distinct, though somewhat superficial, less distinct on vertex, about isodiametric. Surface rather glossy.

Pronotum. Fairly depressed, transverse, quadrate, widest slightly in front of middle, though barely narrowed to base, base much wider than apex. Lateral margin posteriorly almost straight or even feebly concave, faintly oblique. Posterior angles rectangular, faintly produced over lateral part of base. Carina at posterior angle elongate, oblique, slightly incurved. Anterior transverse sulcus rather deep, uninterrupted. Posterior transverse sulcus very deep, interrupted by a large fovea. Anterior lateral seta situated at anterior third of margin. Disk with some shallow, transverse wrinkles in middle, in anterior two fifth on either side with a shallow, punctiform impression. Microreticulation rather indistinct, superficial, slightly transverse. Surface glossy.

Elytra. Fairly elongate, moderately convex, reversely egg-shaped, widest about in middle. Lateral border evenly curved. Disk in anterior third with very slight transverse depression. Sutural stria finely punctulate. 2nd stria barely impressed, finely punctate. 3rd-5th striae just visible as indistinct rows of very spaced and fine punctures. Outer striae almost invisible. Sutural interval convex, 2nd interval barely convex, outer intervals absolutely depressed. 8th stria deeply impressed throughout, finely punctate, attaining posterior marginal pore. Recurrent striae elongate, oblique, meeting position of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior third. Microreticulation indistinct, highly superficial, composed of irregular, transverse meshes, surface highly glossy. Wings fully developed. Variation unknown.

Lower surface. Metepisternum c. 1.5 x as long as wide.

Genitalia. Male unknown. Female stylomere 2 with dorsal ensiform seta situated rather basally.

DISTRIBUTION

Isley Hills, south of Cairns, north Queensland. Known only from type locality.

HABITAT

Collected by pyrethrum knockdown on mossy trees and rocks in montane rainforest at 1050m. Captured end of November.

ETYMOLOGY

For Heather Janetzki, Queensland Museum, collector of many species of *Philipis*.

Philipis picea sp. nov.

(Figs 11F, 18A)

MATERIAL EXAMINED

HOLOTYPE: QMT13522; ♀, Mossman Bluff Track, 9km W Mossman, NEQ, 20 Dec 1989, 860m, Monteith & Thompson, Pyrethrum (Site 6).

DIAGNOSIS

Medium sized, rather elongate and fairly depressed, winged. Easily distinguished by depressed shape and uniform, piceous colour without any elytral pattern. Distinguished from *P. castanea* by wide base of pronotum and absence of transverse depression in anterior third of elytra.

DESCRIPTION

Measurements. Length: 2.50mm; width: 1.16mm. Ratios: Width pronotum/head: 1.40; width/length of pronotum: 1.51; width base/apex of pronotum: 1.57; width widest diameter/base of pronotum: 1.01; length/width of elytra: 1.37.

Colour. Very dark piceous, lateral borders of pronotum and elytra and elytral suture posteriorly faintly lighter. Legs dark yellow, femora slightly infusate.

Head. Median antennomeres c. 1.6 x as long as wide. Microreticulation on labrum, clypeus, and frons fairly distinct, though somewhat superficial, on vertex reduced, about isodiametric. Surface moderately glossy.

Pronotum. Fairly depressed, transverse, widest in front of middle, base much wider than apex. Lateral margin posteriorly very faintly concave, barely oblique, hence pronotum not perceptibly narrowed to posterior angles. Posterior angles rectangular. Carina at posterior angle elongate, oblique, slightly incurved. Anterior transverse sulcus comparatively shallow, uninterrupted. Posterior transverse sulcus very deep, interrupted by a rather large fovea. Anterior lateral seta situated at anterior third of margin. Microreticulation absent, surface highly glossy.

Elytra. Fairly elongate, moderately convex, reversely egg-shaped, widest slightly in front of middle. Lateral border evenly curved. Disk without transverse depression. Sutural stria finely punctulate. All other striae visible as rows of rather fine punctures, though becoming finer laterally and towards apex. 2nd stria in anterior half faintly impressed. Only sutural interval convex, others depressed. 8th stria deeply impressed,

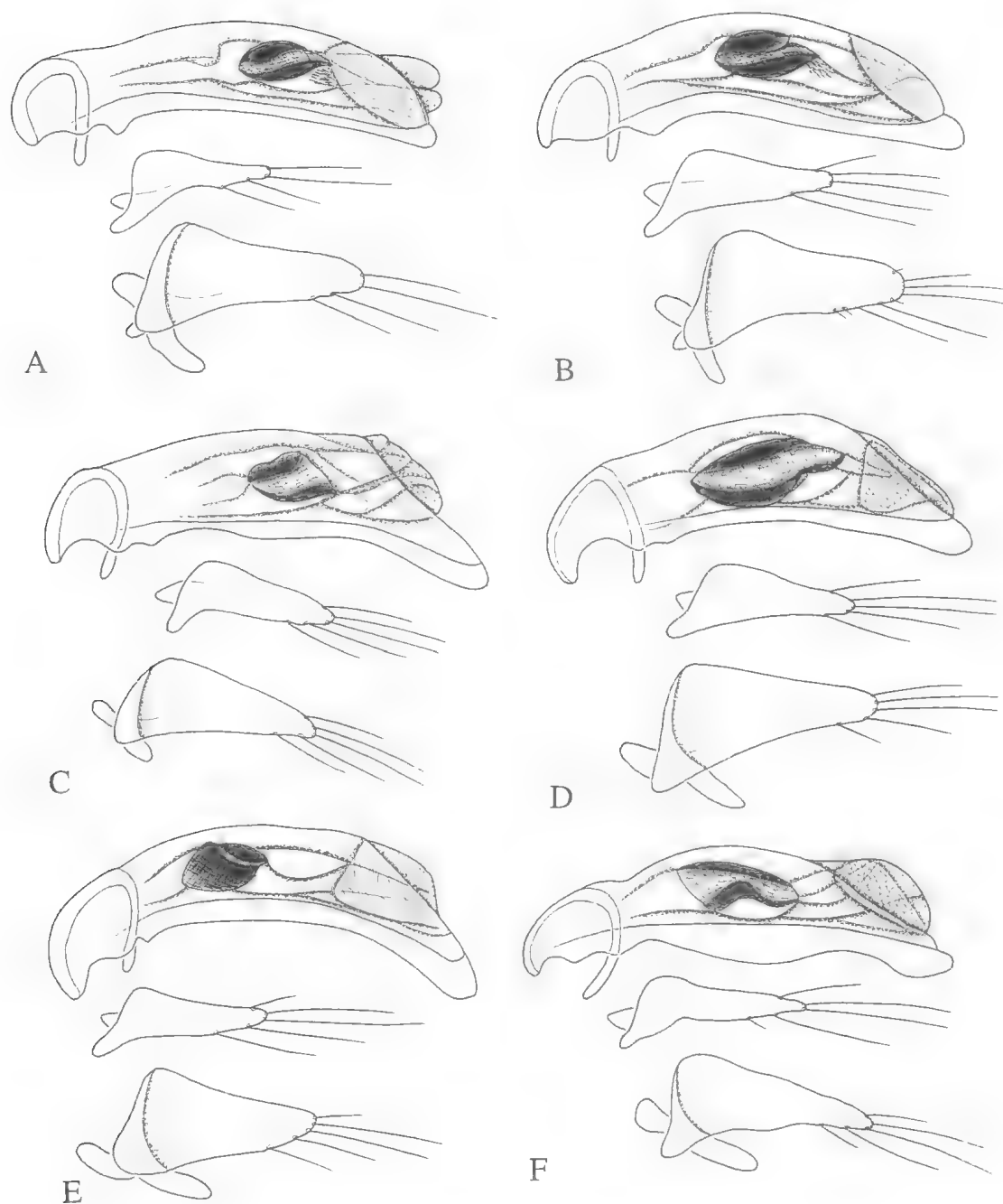


FIG. 4. ♂ genitalia. A, *Philipis cooki* sp. nov. B, *P. laevigata* sp. nov. C, *P. castanea* sp. nov. D, *P. unicolor* sp. nov. E, *P. atra* sp. nov. F, *P. ruficollis* sp. nov.

TABLE 1. Summary of measures and ratios of *Philipis*. l: length (mm); w: width (mm); w p/h: ratio of width pronotum/head; w/l p: ratio of width/length of pronotum; b/a p: ratio of width of base/apex of pronotum; d/b p: ratio of widest diameter/base of pronotum; l/w e: ratio of length/width of elytra.

<i>Philipis</i> <i>species</i>	l	w	w p/h	w/l p	b/a p	d/b p	l/w e
<i>quadranticollis</i>	2.70-2.80	1.20-1.25	1.48-1.49	1.55-1.58	1.57-1.60	0.99	1.43
<i>alticola</i>	2.75	1.24	1.41	1.45	1.48	1.04	1.45
<i>cooki</i>	2.35-2.70	1.10-1.18	1.44-1.48	1.42-1.47	1.45-1.51	1.07-1.09	1.41-1.45
<i>laevigata</i>	2.20	1.00-1.02	1.41-1.44	1.41-1.45	1.39	1.09-1.11	1.41-1.44
<i>heatherae</i>	2.35	1.08	1.41	1.46	1.50	1.03	1.42
<i>picea</i>	2.50	1.16	1.40	1.51	1.57	1.01	1.37
<i>castanea</i>	2.15-2.50	0.95-1.15	1.40-1.45	1.48-1.51	1.50-1.53	1.05-1.07	1.36-1.38
<i>unicolor</i>	1.85-2.25	0.90-1.10	1.54-1.58	1.56-1.60	1.45-1.50	1.10-1.13	1.28-1.30
<i>atra</i>	2.45-2.60	1.12-1.20	1.55-1.58	1.49-1.53	1.39-1.43	1.11-1.13	1.37-1.38
<i>ruficollis</i>	2.35-2.50	1.12-1.15	1.43-1.44	1.42-1.44	1.47-1.49	1.06-1.08	1.37-1.41
<i>inermis</i>	1.95-2.00	0.89-0.90	1.43-1.44	1.32-1.34	1.31-1.33	1.09-1.10	1.36-1.38
<i>reticulata</i>	2.20	1.02	1.45	1.52	1.45	1.07	1.32
<i>striata</i>	2.15-2.45	1.00-1.15	1.50-1.53	1.56-1.58	1.50-1.54	1.03-1.07	1.32-1.34
<i>planicola</i>	2.10-2.20	1.00-1.05	1.48-1.49	1.50-1.54	1.54-1.55	0.97-0.98	1.30-1.31
<i>spurgeoni</i>	2.28	1.08	1.55	1.54	1.44	1.07	1.30
<i>trunci</i>	2.00-2.25	0.95-1.03	1.51-1.56	1.51-1.53	1.38-1.44	1.09-1.13	1.28-1.31
<i>tribulationis</i>	1.95-2.15	0.92-0.98	1.48-1.54	1.50-1.53	1.40-1.42	1.08-1.11	1.31-1.33
<i>thompsoni</i>	2.15-2.30	1.00-1.10	1.51-1.55	1.46-1.52	1.45-1.49	1.08-1.11	1.33-1.34
<i>vicina</i>	2.20	1.00	1.52	1.55	1.40	1.10	1.33
<i>laevis</i>	2.05-2.30	1.04-1.12	1.58-1.62	1.43-1.49	1.41-1.45	1.12-1.15	1.24-1.28
<i>sulcata</i>	2.05-2.50	0.95-1.20	1.58-1.64	1.53-1.57	1.48-1.57	1.11-1.15	1.27-1.31
<i>frerei</i>	2.05-2.45	1.00-1.15	1.60-1.64	1.44-1.51	1.42-1.48	1.11-1.19	1.31-1.34
<i>subtropica</i>	2.30-2.80	1.00-1.25	1.54-1.64	1.42-1.47	1.43-1.47	1.13-1.15	1.35-1.36
<i>alutacea</i>	2.25-2.45	1.05-1.12	1.64-1.68	1.46-1.49	1.63-1.67	1.04-1.06	1.32-1.35
<i>rufescens</i>	2.15-2.45	1.02-1.10	1.56-1.63	1.36-1.45	1.38-1.41	1.12-1.18	1.37-1.38
<i>perstriata</i>	2.05	0.90	1.64	1.41	1.37	1.17	1.39
<i>elliotti</i>	2.00-2.15	0.90-1.00	1.50-1.53	1.38-1.46	1.28-1.43	1.12-1.16	1.35-1.41
<i>agnicapitis</i>	1.85-2.30	0.85-1.05	1.50-1.57	1.39-1.42	1.34-1.37	1.13-1.15	1.34-1.39
<i>picta</i>	2.18-2.35	1.02-1.04	1.48-1.51	1.45-1.49	1.35-1.40	1.12-1.16	1.31-1.34
<i>bicolor</i>	2.00-2.45	0.92-1.15	1.50-1.55	1.53-1.61	1.44-1.49	1.07-1.09	1.32-1.36
<i>geoffreyi</i>	2.12-2.16	1.02-1.04	1.51-1.55	1.55-1.57	1.42-1.46	1.08-1.09	1.29-1.31
<i>minor</i>	2.00	0.96	1.45	1.47	1.34	1.11	1.35
<i>sinuata</i>	2.60-2.75	1.20-1.30	1.65-1.73	1.51-1.56	1.51-1.59	1.09-1.11	1.34-1.36
<i>distinguenda</i>	2.60-2.65	1.18-1.24	1.59-1.60	1.45-1.47	1.45-1.47	1.10-1.12	1.38-1.41
<i>lustrans</i>	2.20-2.50	1.00-1.16	1.56-1.62	1.51-1.57	1.46-1.51	1.09-1.13	1.33-1.37

finely punctate, becoming shallower anteriorly, attaining posterior marginal pore. Recurrent striae elongate, oblique, meeting 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior 2/5. Microreticulation absent, surface highly glossy. Wings fully developed. Variation unknown.

Lower surface. Metepisternum elongate, c. 1.5 x as long as wide.

Genitalia. Male unknown. Female stylomere 2 with dorsal ensiform seta situated rather basally.

DISTRIBUTION

Mountains west of Mossman, north Queensland. Known so far from type locality only.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks in montane rainforest at 850m. Collected December only.

ETYMOLOGY

Refers to the piceous colour.

***Philipis castanea* sp. nov.**
(Figs 4C, 12A, 18A)

MATERIAL EXAMINED

HOLOTYPE: QMT13523; ♂, Thornton Peak summit, via Daintree, NEQ, 24-27 Sept 1984, G. B. & S. R. Monteith/QM Berleseate No. 662, Rainforest, 1100-1300m, sieved litter & moss.

PARATYPES: 2 ♂, 4 ♀, Thornton Peak, 11km NE Daintree, NEQ, 1000-1200m, 30 Oct-1 Nov 1983, GM, DY & GT (ANIC, CBM, QM, ZSM); 2 ♂, 4 ♀, Thornton Peak via Daintree, NEQ, 1000-1300m, 20-22 Sept 1981, GM & DC (CBM, QM, USNM); 1 ♂, 4.5-5.0km W of Cape Tribulation, Top Camp, NEQ, 760-780m, 27 Sept-7 Oct 1982, GM, DY & GT (QM); 2 ♂, 1 ♀, 4.5-5.0km W of Cape Tribulation, Top Camp, NEQ, 1-6 Oct 1982, 760-780m, GM, DY & GT, Pyr., RF (QM); 1 ♀, 5.0km W of Cape Tribulation, NEQ, (Site 10), 28 Sept 1982, 780m, GM, DY & GT, Pyr., RF (QM).

DIAGNOSIS

Medium sized, rather elongate and fairly depressed, winged. Easily distinguished by depressed shape and uniform, chestnut brown colour without any elytral pattern. Distinguished from *P. picea* by narrower base of pronotum and presence of a transverse depression in anterior third of elytra.

DESCRIPTION

Measurements. Length: 2.15-2.50mm; width: 0.95-1.15mm. Ratios: Width pronotum/head: 1.40-1.45; width/length of pronotum: 1.48-1.51; width base/apex of pronotum: 1.50-1.53; width widest diameter/base of pronotum: 1.05-1.07; length/width of elytra: 1.36-1.38.

Colour. Chestnut brown, head piceous, elytral suture posteriorly faintly lighter. Legs yellow, tibiae sometimes faintly darker.

Head. Median antennomeres c. 1.75 x as long as wide. Microreticulation present on labrum, clypeus, and frons, but very indistinct and superficial, about isodiametric, visible only under high magnification. Surface glossy.

Pronotum. Fairly depressed, transverse, widest in front of middle, base much wider than apex. Lateral margin posteriorly feebly rounded or even almost straight, though somewhat oblique.

Posterior angles rectangular. Carina at posterior angle elongate, oblique, slightly incurved. Anterior transverse sulcus comparatively shallow, uninterrupted. Posterior transverse sulcus very deep, interrupted by a rather large fovea. Anterior lateral seta situated at anterior third of margin. Microreticulation absent, surface highly glossy.

Elytra. Fairly elongate, moderately convex, reversely egg-shaped, widest slightly in front of middle. Lateral border evenly curved. Disk in anterior third at position of anterior discal seta with shallow transverse depression. Sutural stria punctulate. 2nd stria visible as a row of small punctures, in anterior half even faintly impressed. 3rd-5th striae anteriorly more or less well visible as indistinct rows of extremely fine punctures. Outer striae absent. Intervals, apart from sutural and 2nd in anterior half, absolutely depressed. 8th stria deeply impressed, punctate, posteriorly punctate-crenulate, attaining posterior marginal pore. Recurrent striae elongate, oblique, meeting position of 3rd stria. Anterior discal pore in anterior third, posterior pore behind middle. Microreticulation absent, except for the very apex, surface highly glossy. Wings fully developed.

Lower surface. Metepisternum c. 1.5 x as long as wide.

Male genitalia. Genital ring regularly triangular, apex rather acute. Aedeagus large, lower surface slightly bisinuate, apex stout, elongate, slightly bent down, at tip rounded off. Both parameres 5-setose.

Female genitalia. Stylomere 2 with dorsal ensiform seta situated rather basally.

Variation. Apart from some variation of shape of pronotum and distinctness of elytral striae, little variation noted.

DISTRIBUTION

Thornton Peak and adjacent uplands above Cape Tribulation, north of Daintree, north Queensland.

HABITAT

A montane species, occurring in rainforest above 750m. Collected by pyrethrum knockdown on mossy tree trunks and by Berlese extraction of litter and moss. Collected only in the period of September-November.

ETYMOLOGY

Refers to the castaneous colour of upper surface.

***Philipis unicolor* sp. nov.**
(Figs 4D, 12B, 18A)

MATERIAL EXAMINED

HOLOTYPE: QMT13536; ♂, Bellenden Ker, Cableway Tower No 3, NEQ, 1000m, Pyrethrum/trees, 25 Sept 1981, G. Monteith.

PARATYPES: 2 ♂, 10 ♀, same data (ANIC, CBM, QM, USNM, ZSM); 1 ♂, 5 ♀, Bellenden Ker Range, Cable Tower 3, NEQ, 1054m, 17 Oct-5 Nov 1981, EW/QM, Pyr. (CBM, QM); 1 ♀, Bellenden Ker Range, Cable Tower 3, NEQ, 1054m, 17-24 Oct 1981, EW/QM, Pyr. on logs, stones and tree trunks (QM); 1 ♀, Bartle-Frere, NW Peak, NEQ, 1440m, Pyr. on mossy rocks 24 Sept 1981, GM (QM); 2 ♂, Mt. Bartle Frere, NEQ, West Side, 1050m, 8 Dec 1990, GM, GT & RS, Pyr.-trees & rocks (QM); 1 ♀, Bell Peak North 10km E Gordonvale, NFQ, 13 Oct 1982, 900-1000m, GM, DY & GT, Pyr., RF (QM).

DIAGNOSIS

Small, piceous, unpatterned, short and highly convex, distinguished from *P. atra* sp. nov. by smaller size (length), lighter colour, evenly convex posterior part of lateral margin of pronotum, shorter elytra, and shorter and wider apex and evenly rounded lower surface of aedeagus.

DESCRIPTION

Measurements. Length: 1.85-2.25mm; width: 0.9-1.1mm. Ratios: Width pronotum/head: 1.54-1.58; width/length of pronotum: 1.56-1.60; width base/apex of pronotum: 1.45-1.50; width widest diameter/base of pronotum: 1.10-1.13; length/width of elytra: 1.28-1.30.

Colour. Piceous, sutural interval and marginal channel of elytra reddish. Elytra without pattern. Antenna yellow. Legs yellow, femora reddish to reddish-brown.

Head. Median antennomeres c. 1.35 x as long as wide. Microreticulation on frons barely visible, on labrum and anterior border of clypeus distinct, isodiametric. Surface glossy.

Pronotum. Moderately convex, transverse, widest in middle, base much wider than apex. Lateral margin evenly curved, though slightly more curved to apex than to base. Posterior angles rectangular, faintly produced over lateral part of base. Carina at posterior angle elongate, oblique, slightly incurved. Anterior transverse sulcus comparatively shallow, uninterrupted. Posterior transverse sulcus deep, interrupted by a large fovea. Anterior lateral seta situated slightly behind anterior third of margin. Microreticulation absent, surface highly glossy.

Elytra. Short and highly convex, lateral border evenly curved, widest in middle. Lateral margin

extremely finely serrate and pilose. Sutural stria in anterior half coarsely punctate, posteriorly impunctate. 2nd stria in basal half indicated as a row of rather coarse punctures, but stria beginning only at some distance from base, posteriorly almost reduced. Outer striae composed of extremely fine rows of delicate punctures, posteriorly almost reduced, difficult to recognize. Only sutural interval and 2nd interval in basal third, slightly convex. 8th stria deeply impressed, loosely punctate, not attaining posterior marginal pore. Recurrent striae rather short, markedly oblique, only anteriorly shortly incurved and hardly meeting position of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly behind middle. Microreticulation absent, surface highly glossy. Wings absent.

Lower surface. Metepisternum about as long as wide.

Male genitalia. Genital ring almost symmetrical, apex rather wide. Aedeagus short and compact, lower surface slightly and evenly curved. Apex short, thick, rounded off. Both parameres 5-setose.

Female genitalia. Stylocere 2 with dorsal ensiform seta situated rather basally.

Variation. Apart from some, partly sexual, differences of size, and some differences of relative shape of pronotum, little variation noted.

DISTRIBUTION

Bellenden Ker Range and nearby Malbon Thompson Range, east of Atherton Tableland, north Queensland.

HABITAT

Collected by pyrethrum knockdown of mossy trees and rocks in montane rainforest above 900m, in the period of September to November.

ETYMOLOGY

Refers to the unpatterned dorsal surface.

***Philipis atra* sp. nov.**
(Figs 4E, 12C, 17A)

MATERIAL EXAMINED

HOLOTYPE: QMT13553; ♂, 20°50'S, 148°34'E Mt. Macartney, CEQ, 19 Nov 1992, 900m Monteith, Thompson & Janetzki, Pyrethrum.

PARATYPES: 2 ♀, same data (CBM, QM).

DIAGNOSIS

Medium sized, black, unpatterned, short and highly convex, distinguished from *P. unicolor* sp. nov. by larger size (length 2.45mm), darker col-

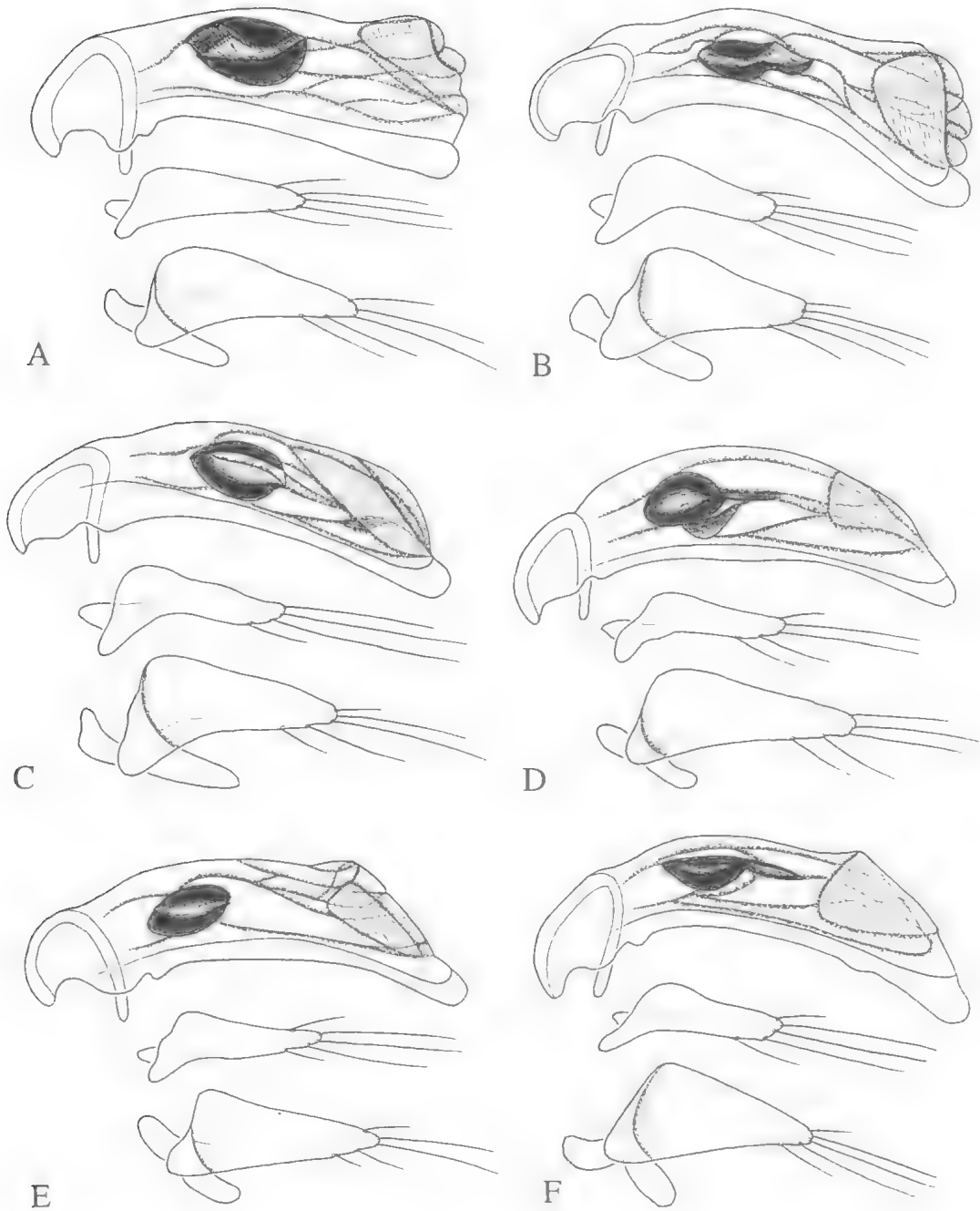


FIG. 5. ♂ genitalia. A, *Philipis inermis* sp. nov. B, *P. striata* sp. nov. C, *P. planicola* sp. nov. D, *P. trunci* (Darlington). E, *P. tribulationis* sp. nov. F, *P. thompsoni* sp. nov.

our, irregularly convex posterior part of lateral margin of pronotum, longer clytra, and longer and narrower apex and basally straight lower surface of aedeagus.

DESCRIPTION

Measurements. Length: 2.45-2.60mm; width: 1.12-1.20mm. Ratios: Width pronotum/head: 1.55-1.58; width/length of pronotum: 1.49-1.53; width base/apex of pronotum: 1.39-1.43; width widest diameter/base of pronotum: 1.11-1.13; length/width of elytra: 1.37-1.38.

Colour. Completely black or very dark piceous-black. Elytra without pattern. Legs dirty yellow, femora barely darker.

Head. Median antennomeres slightly $<1.5 \times$ as long as wide. Microreticulation on frons rather superficial, on labrum and anterior border of clypeus distinct, isodiametric. Surface glossy.

Pronotum. Moderately convex, transverse, widest in middle, base much wider than apex. Lateral margin anteriorly evenly curved, though posteriorly with a faint compression behind mid-dly, and near basal angles curved in. Posterior angles rectangular, at apex obtuse, not produced over lateral part of base. Carina at posterior angle elongate, oblique, slightly incurved. Anterior transverse sulcus comparatively shallow, uninterrupted. Posterior transverse sulcus deep, interrupted by a large fovea. Anterior lateral seta situated slightly behind anterior third of margin. Microreticulation absent, surface highly glossy.

Elytra. Rather short and highly convex, egg-shaped, widest in middle. Lateral border evenly curved, extremely finely serrate and pilose. Sutural stria in anterior half finely punctate, posteriorly impunctate, 2nd stria in basal half slightly impressed, finely punctate, but stria beginning only at some distance from base, becoming weaker towards apex. Outer striae gradually finer towards lateral margin, striae composed of rows of fine punctures, the outer ones posteriorly almost reduced, difficult to recognize. Only sutural interval and 2nd interval in basal half, slightly convex. 8th stria deeply impressed, loosely punctate, just attaining posterior marginal pore. Recurrent striae rather short, markedly oblique, anteriorly barely incurved, not attaining position of 3rd stria. Anterior discal pore situated in anterior third, posterior pore in posterior third. Microreticulation absent, except for near apex, surface highly glossy. Wings present.

Lower surface. Metepisternum slightly longer than wide.

Male genitalia. Genital ring almost symmetrical, apex rather wide. Aedeagus short and compact, lower surface basally straight, then evenly curved. Apex short, rather compact, rounded off. Both parameres 5-setose.

Female genitalia. Stylomere 2 with very stout dorsal ensiform seta situated about medially.

Variation. Apart from some minor differences in size and relative shape of pronotum, little variation noted.

DISTRIBUTION

Mt. Macartney north of Eungella National Park, central eastern Queensland. Known only from this mountain top.

HABITAT

Collected in montane rainforest above 900m by pyrethrum knockdown, on mossy tree trunks. Collected November only.

ETYMOLOGY

Refers to the unicolorous black surface.

***Philipis ruficollis* sp. nov.**
(Figs 4F, 12D, 18B)

MATERIAL EXAMINED

HOLOTYPE: QMT13555; ♂, Mt. Finnigan, 850-1100m, 37km S Cooktown, NEQ, 19-22 Apr 1982, RF Monteith, Yeates & Cook.

PARATYPES: 1 ♂, same data (CBM); 1 ♀ Mt. Finnigan, 1100m, 37km S Cooktown, NEQ, 20 Dec 1982, LR, Pyr. (QM); 1 ♂, Mt. Finnigan Summit via Helenvale, NEQ, 3-5 Dec 1990, 1050m, GM, GT, DC, RS & LR (QM); 1 ♂, Mt. Finnigan Summit via Helenvale, NEQ, 28-30 Nov 1985, 1100m, GM, DC & LR (QM); 1 ♂, Mt. Finnigan Summit via Helenvale, NEQ, 28 Nov 1985, 1100m, GM & DC, Pyr/RF (QM); 2 ♂, Mt. Finnigan Summit via Helenvale, NEQ, 3-5 Dec 1990, 1050m, GM, RS, LR & GT, Pyr. (ANIC, QM).

DIAGNOSIS

Medium sized, moderately convex, distinguished by rufous pronotum, almost transverse elytral fascia not s-shaped, and strongly bisinuate lower surface of aedeagus.

DESCRIPTION

Measurements. Length: 2.35-2.50mm; width: 1.12-1.15mm. Ratios: Width pronotum/head: 1.43-1.44; width/length of pronotum: 1.42-1.44; width base/apex of pronotum: 1.47-1.49; width widest diameter/base of pronotum: 1.06-1.08; length/width of elytra: 1.37-1.41.

Colour. Head and elytra dark piceous, pronotum contrastingly reddish. Elytra with an ill-de-

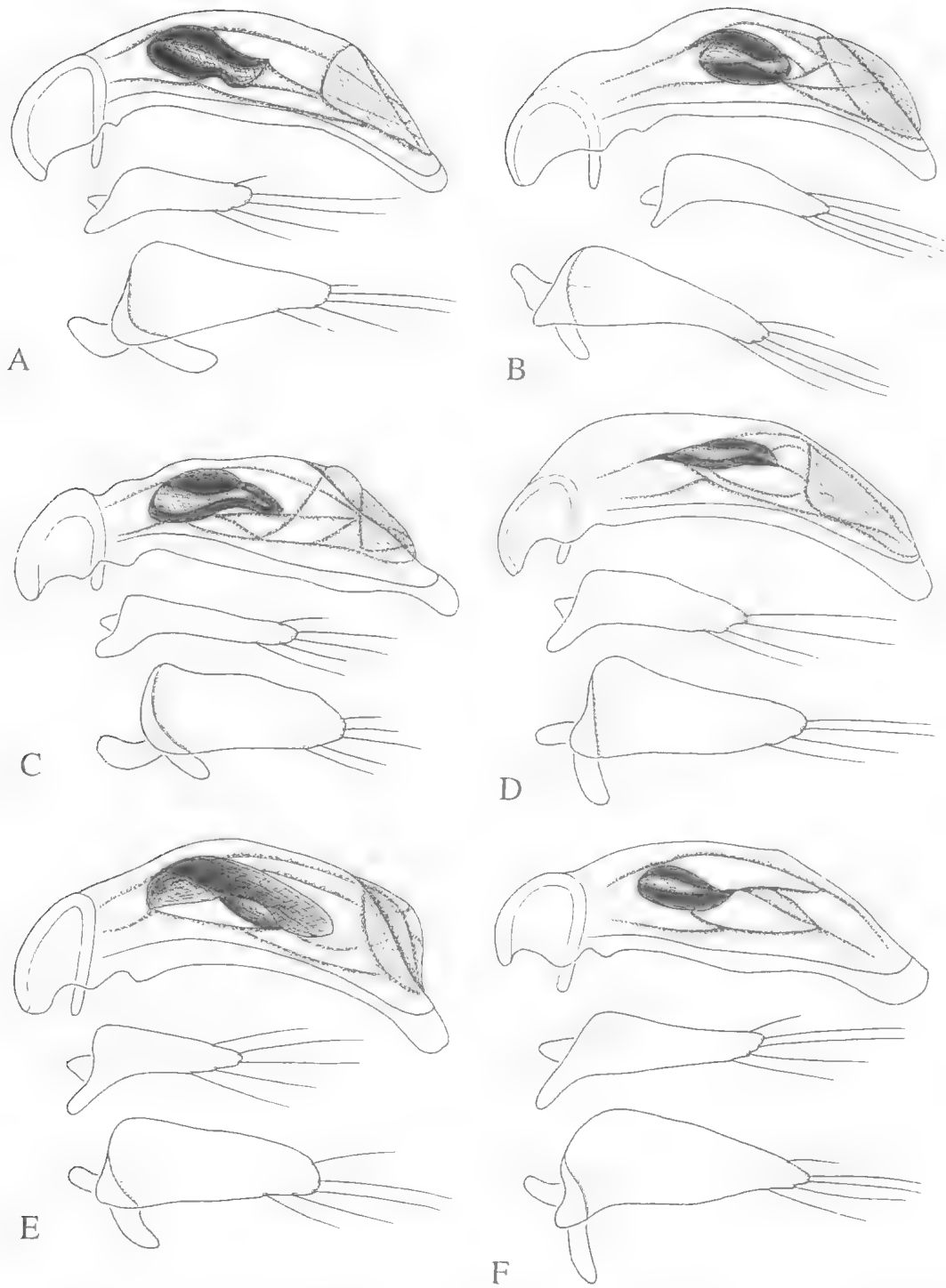


FIG. 6. ♂ genitalia. A, *Philipis vicina* sp. nov. B, *P. laevis* sp. nov. C, *P. sulcata* sp. nov. D, *P. frerei* sp. nov. E, *P. subtropica* sp. nov. F, *P. alutacea* sp. nov.

lined, somewhat transverse spot in posterior 2/5 not reaching suture nor lateral border, and suture posteriorly reddish. Legs yellow.

Head. Median antennomeres c. 1.3 x as long as wide. Microreticulation visible on frons, though rather superficial, almost reduced on vertex, about isodiametric. Surface rather glossy.

Pronotum. Rather depressed, transverse, widest slightly in front of middle, base much wider than apex. Lateral margin posteriorly almost straight, though somewhat oblique. Posterior angles rectangular, feebly produced over lateral part of base. Marginal Lateral channel posteriorly slightly punctate. Carina at posterior angle elongate, oblique, slightly incurved. Anterior transverse sulcus rather shallow, slightly interrupted or at least becoming shallower. Posterior transverse sulcus very deep, interrupted by a rather small, inconspicuous fovea. Anterior lateral seta situated slightly behind anterior third of margin. Microreticulation completely absent, surface highly glossy.

Elytra. Moderately elongate, fairly convex, reversely egg-shaped, widest well in front of middle. Lateral border evenly curved. Sutural stria crenulate. Other striae in anterior half well developed as rows of fairly coarse punctures, though 6th and 7th striae very delicate. All striae posteriorly reduced. Only sutural interval convex. 8th stria deeply impressed, punctate, attaining posterior marginal pore. Recurrent striae elongate, meeting position of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly behind posterior 2/5. Microreticulation on disk completely absent, but present as superficial transverse meshes at apex. Surface of disk highly glossy. Wings fully developed. Little variation noted.

Lower surface. Metepisternum c. 1.3 x as long as wide.

Male genitalia. Genital ring triangular, slightly asymmetrical, apex rather acute. Aedeagus rather short and compact, lower surface remarkably bisinuate, apex slightly bent down, short, widely rounded off. Both parameres 5-setose.

Female genitalia. Stylomere 2 with dorsal ensiform seta situated rather medially.

DISTRIBUTION

Mt. Finnigan south of Cooktown, north Queensland. Known only from that mountain top.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks in montane rainforest above 850m. Collected April and November-December.

ETYMOLOGY

Refers to the red colour of pronotum.

Philipis inermis sp. nov.

(Figs 5A, 12E, 18B)

MATERIAL EXAMINED

HOLOTYPE: QMT13561; ♂, Mt. Finnigan Summit, NEQ, 29 Nov 1985, G. Monteith, QM Berlesate No. 699, 15°48'S 145°17'E, moss on trees.

PARATYPES: 1 ♂, Mt. Finnigan, 1100m, 37km S Cooktown, NEQ, 20 Dec 1982, LR, Pyr. (CBM).

DIAGNOSIS

Small, narrow, distinguished by small size, narrow pronotum, and apical elytral fascia not s-shaped.

DESCRIPTION

Measurements. Length: 1.95-2.0mm; width: 0.89-0.90mm. Ratios: Width pronotum/head: 1.43-1.44; width/length of pronotum: 1.32-1.34; width base/apex of pronotum: 1.31-1.33; width widest diameter/base of pronotum: 1.09-1.10; length/width of elytra: 1.36-1.38.

Colour. Very dark piceous to almost black, pronotum faintly lighter, posterior half of elytral suture reddish. Elytra with a moderately well-defined, slightly transverse, dark yellow or light reddish spot in posterior 2/5 medially reaching almost to 2nd stria. Legs reddish-piceous, apex of femora and tibiae, and tarsi yellow. Lower surface piceous, anteriorly even slightly darker.

Head. Median antennomeres c. 1.15 x as long as wide. Microreticulation distinct on labrum and clypeus, becoming more superficial on frons, almost absent on vertex, anteriorly about isodiametric, posteriorly slightly transverse. Surface fairly glossy.

Pronotum. Comparatively narrow, convex, widest about in middle, base not much wider than apex. Lateral margin evenly curved, but slightly less so posteriorly. Posterior angles subrectangular, slightly obtuse, not produced over lateral part of base. Carina at posterior angle comparatively short, oblique, slightly incurved. Anterior transverse sulcus moderately deep, barely interrupted. Posterior transverse sulcus deep, slightly interrupted. Anterior lateral seta situated well behind anterior third of margin. Microreticulation super-

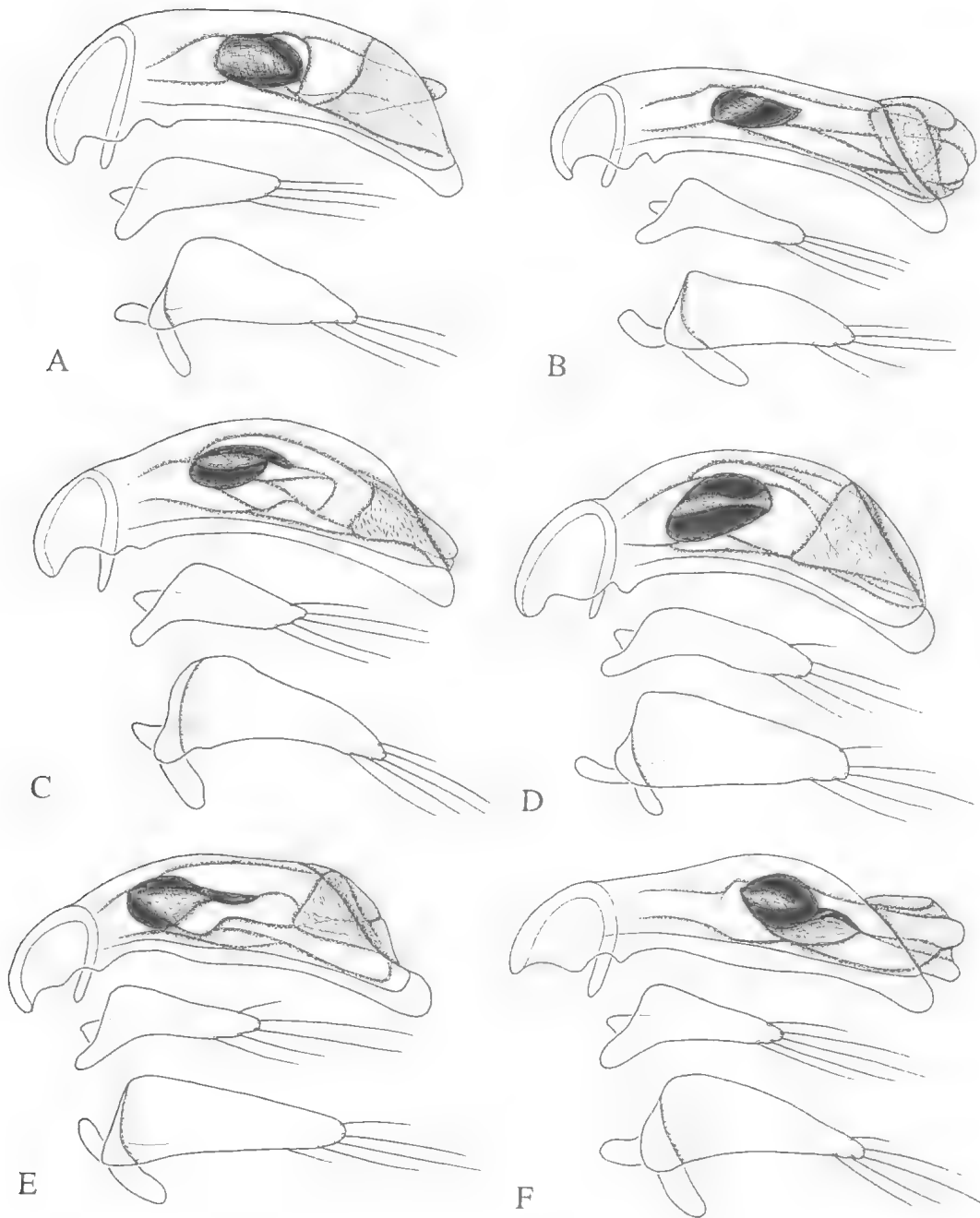


Fig. 7. ♂ genitalia. A, *Philipis rufescens* sp. nov. B, *P. ellioti* sp. nov. C, *P. agnicapitis* sp. nov. D, *P. picta* sp. nov. E, *P. bicolor* sp. nov. F, *P. geoffreyi* sp. nov.

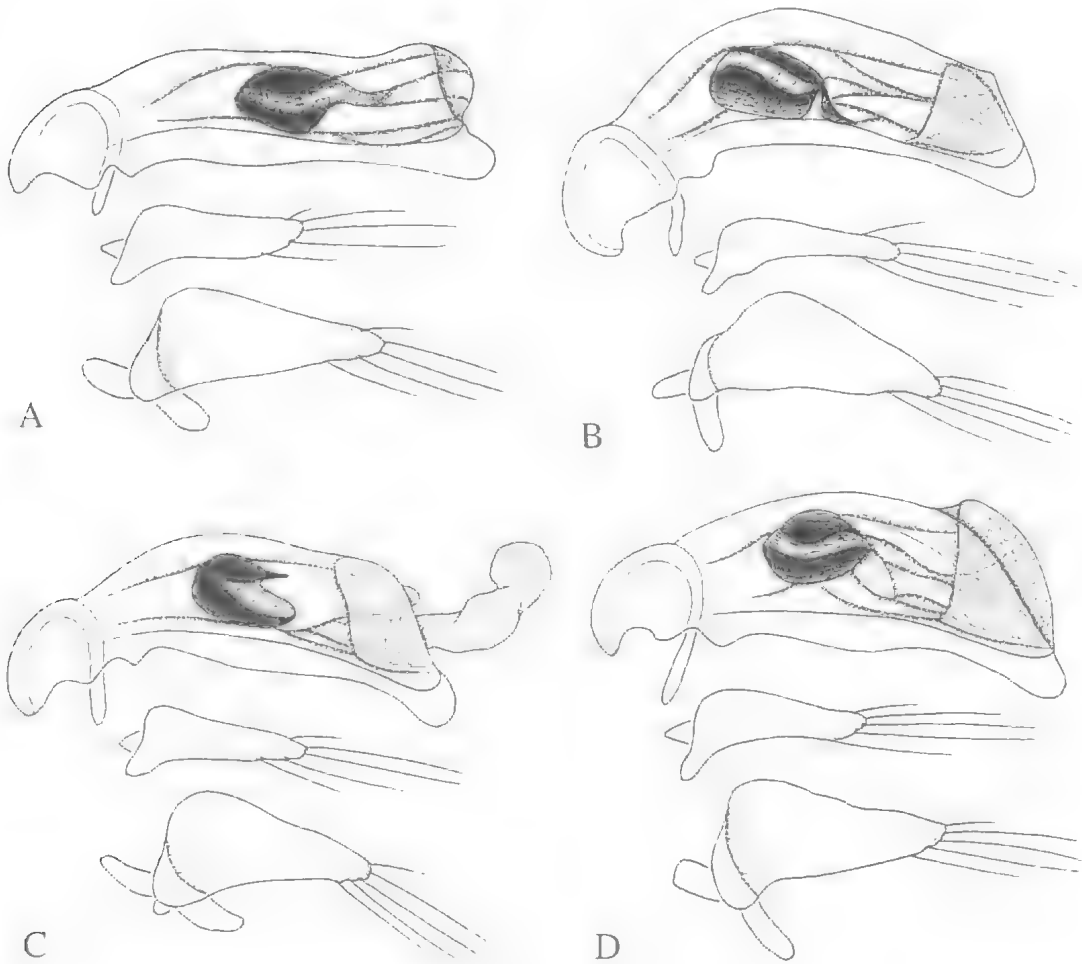


FIG. 8. ♂ genitalia. A, *Philipis minor* sp. nov. B, *P. sinuata* sp. nov. C, *P. distinguenda* sp. nov. D, *P. lustrans* sp. nov.

ficial, though visible, slightly transverse, surface fairly glossy.

Elytra. Short, convex, egg-shaped, widest about in middle. Lateral border evenly curved, finely serrate and pilose throughout. Sutural stria in basal half punctate, anteriorly barely recurved and not deepened. 2nd and 3rd striae near base indicated as rows of moderately fine punctures, reduced posteriorly. Outer striae almost invisible, at most 4th and 5th vaguely indicated near base. Only sutural stria well marked to apex. Only sutural interval and 2nd interval in basal half somewhat convex. 8th stria posteriorly deeply impressed, punctate, becoming weaker anteriorly, not attaining posterior marginal pore. Re-

current striae markedly oblique, meeting position of 3rd stria. Ridge laterally bordering recurrent striae markedly carinate. Anterior discal pore in anterior third, posterior pore slightly in front of posterior third. Microreticulation distinct, rather coarse, though slightly superficial, composed of moderately transverse meshes. Surface but moderately glossy. Wings slightly shortened. No perceptible variation noted.

Lower surface. Metepisternum barely longer than wide.

Genitalia. Male genital ring regularly triangular, narrow, slightly asymmetrical, apex rather wide. Aedeagus short and compact, lower surface straight, apex very short, widely rounded off.

Parameres moderately elongate, both 5-setose. Female genitalia unknown.

DISTRIBUTION

Known only from mountain top, Mt. Finnigan south of Cooktown, north Queensland.

HABITAT

Collected by pyrethrum knockdown and Berlese extraction of mossy tree trunks in montane rainforest above 1100m. Collected November and December.

ETYMOLOGY

Refers to the small size and narrow shape.

Philipis reticulata sp. nov.
(Figs 12F, 18B)

MATERIAL EXAMINED

HOLOTYPE: QMT13562; ♀, Bellenden Ker Range, NEQ, Cable Tower 3, 1054m, 17-24 Oct 1981, Earthwatch/Qld. Museum.

DIAGNOSIS

Small, convex, with s-shaped fascia in posterior half of elytra. Distinguished by well developed striae and presence of distinct microreticulation on elytra.

DESCRIPTION

Measurements. Length: 2.20mm; width: 1.02mm. Ratios: Width pronotum/head: 1.45; width/length of pronotum: 1.52; width base/apex of pronotum: 1.45; width widest diameter/base of pronotum: 1.07; length/width of elytra: 1.32.

Colour. Piceous, base and apex of elytra faintly lighter. Elytra with a well delimited, conspicuous, oblique, rather s-shaped, yellow fascia in posterior 2/5 medially slightly surpassing 2nd stria. Legs yellow.

Head. Frons medially of facial sulcus on either side with two distinct, rather deep, circular impressions. Facial sulci on clypeal suture with a conspicuous circular groove. Median antennomeres c. 1.2 x as long as wide. Microreticulation distinct on labrum and whole clypeus, more superficial, though still distinct on frons, reduced on vertex, about isodiametric to slightly transverse. Surface moderately glossy.

Pronotum. Transverse, convex, widest about in middle, base much wider than apex. Lateral margin posteriorly almost straight, even very faintly concave in front of posterior angles, slightly oblique. Posterior angles rectangular, feebly produced over lateral part of base. Carina at posterior

angle elongate, markedly oblique, slightly incurved. Anterior transverse sulcus rather deep, barely interrupted. Posterior transverse sulcus very deep, interrupted by a large fovea. Anterior lateral seta situated well behind anterior third of margin. Microreticulation absent on disk, though still present on base and apex, surface glossy.

Elytra. Short, highly convex, egg-shaped, widest about in middle. Lateral border evenly curved, extremely finely serrate and pilose. Sutural stria crenulate. All other striae well impressed and coarsely punctate at least in basal half, visible right to apex. Almost all intervals convex, though lateral intervals less so than in middle. 8th stria deeply impressed throughout, strongly punctate-crenulate, attaining posterior marginal pore without becoming shallower. Recurrent striae rather oblique, meeting end of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior third. Microreticulation distinct and conspicuous, composed of rather irregular, moderately transverse meshes. Surface rather dull. Wings almost fully developed. Variation unknown.

Lower surface. Metepisternum slightly longer than wide.

Genitalia. Male unknown. Female stylomere 2 with very stout dorsal ensiform seta situated rather basally.

DISTRIBUTION

Bellenden Ker Range, north Queensland. Known only from type locality.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks in montane rainforest at 1050m. Collected October.

ETYMOLOGY

Refers to the markedly microreticulate surface of elytra.

Philipis striata sp. nov.
(Figs 5B, 13A, 18B)

MATERIAL EXAMINED

HOLOTYPE: QMT13563; ♂, 1.5km W of Cape Tribulation (Site 3), NEQ, 7 Oct 1982, 150m, Monteith, Yeates & Thompson, Pyrethrum knockdown, RP. PARATYPES: 3 ♀, same data (CBM, QM); 1 ♂, Mossman Bluff Track, 8km W Mossman, NEQ, 20 Dec 1989, 600m, GM & GT, Pyr. (Site 4) (QM).

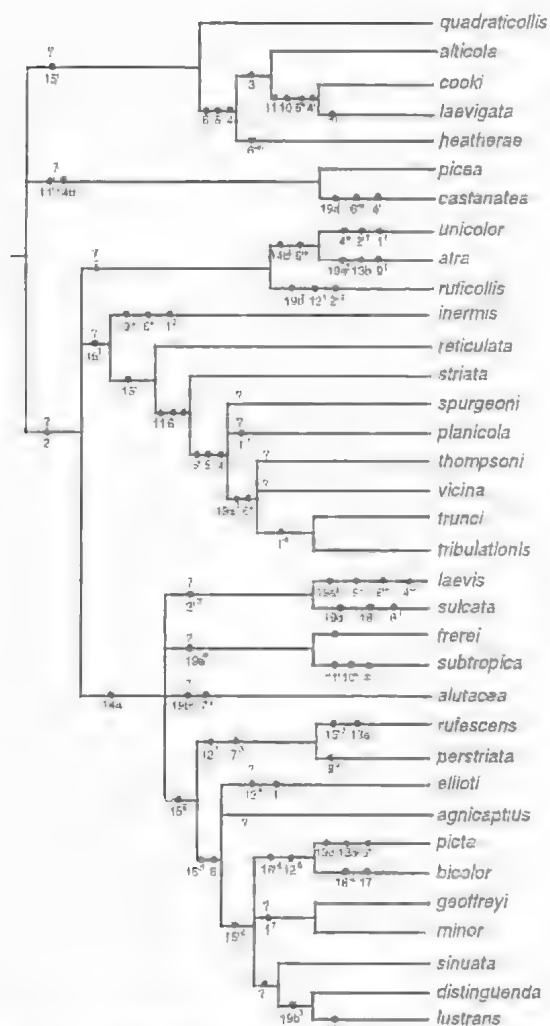


FIG. 9. Cladogram of the supposed relationships of the species of genus *Philipis*. Numbers of synapomorphies refer to Tables 1 and 2. Different apomorphic states distinguished by lower case letters. States of a morphocline indicated by: ', ', ', '. Comparable or similar apomorphic states that are likely to have been convergently evolved marked by numbers: 1, 2 etc.

DIAGNOSIS

Medium sized, convex, with s-shaped fascia in posterior half of elytra. Distinguished by well developed outer striae but depressed intervals, and by weak microreticulation of elytra.

DESCRIPTION

Measurements. Length: 2.15-2.45mm; width: 1.0-1.15mm. Ratios: Width pronotum/head: 1.50-1.53; width/length of pronotum: 1.56-1.58; width base/apex of pronotum: 1.50-1.54; width

widest diameter/base of pronotum: 1.03-1.07; length/width of elytra: 1.32-1.34.

Colour. Dark piceous, pronotum, base to anterior third or half, and apex of elytra slightly lighter, posterior half of suture even lighter, reddish-piceous. Elytra with a well-defined, contrasting, oblique, s-shaped, dark yellow or light reddish fascia in posterior 2/5 medially reaching 2nd stria. Legs yellow.

Head. Median antennomeres c. 1.3 x as long as wide. Microreticulation distinct on labrum and anterior border of clypeus, superficial and rather difficult to see on frons, absent on vertex, about isodiametric. Surface fairly glossy.

Pronotum. Transverse, convex, widest about in middle, base much wider than apex. Lateral margin posteriorly almost straight, slightly oblique. Posterior angles rectangular, feebly produced over lateral part of base. Carina at posterior angle elongate, markedly oblique, slightly incurved. Anterior transverse sulcus rather deep, barely interrupted. Posterior transverse sulcus very deep, interrupted by a large, deep fovea. Anterior lateral seta situated slightly behind anterior third of margin. Microreticulation completely absent, surface highly glossy.

Elytra. Short, highly convex, egg-shaped, widest about in middle. Lateral border evenly curved, extremely finely serrate and pilose. Sutural stria crenulate. Other striae well developed as rows of coarse punctures, laterally and posteriorly not perceptibly finer. 2nd-5th striae in anterior half even slightly impressed. All striae well marked to apex. Sutural interval and basal part of 2nd and even 3rd intervals somewhat convex. 8th stria deeply impressed, punctate-crenulate, barely attaining posterior marginal pore. Recurrent striae rather evenly curved, meeting end of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior third. Microreticulation on disk very superficial, though well visible when seen from laterally or posteriorly, composed of transverse meshes. Surface rather glossy. Wings slightly shortened.

Lower surface. Metepisternum slightly longer than wide.

Male genitalia. Genital ring regularly triangular, slightly asymmetrical, apex rather elongate. Aedeagus rather short and compact, lower surface feebly curved, apex perceptibly bent down short, widely rounded off. Parameres remarkably short, both 5-setose.

Female genitalia. Stylomere 2 with dorsal ensiform seta situated rather medially.

Variation. Apart from some differences of size and of shape of pronotum, little variation noted.

DISTRIBUTION

Lowlands at Cape Tribulation and foothills of Carbine Tableland west of Mossman, north Queensland.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks in rainforest of low and middle elevation below 600m. Collected October and December.

ETYMOLOGY

Refers to the complete striation of elytra.

***Philipis planicola* sp. nov.**
(Figs 5C, 13B, 18C)

MATERIAL EXAMINED

HOLOTYPE: QMT13567; ♂, Bellenden Ker Range, NEQ Cableway Base Stn, 100m, 17 Oct-9 Nov 1981. Earthwatch/Qld. Museum, pyrethrum knockdown.

PARATYPES: 1 ♂, 1 ♀, Russell R. at Bellenden Ker Landing, NEQ, 5m, 1 Nov 1981, EW/QM, QM Berlesate No. 361, 17°16'S, 145°57'E, palm swamp, moss on tree trunks (CBM, QM).

DIAGNOSIS

Small, convex, with s-shaped fascia in posterior half of elytra. Distinguished species by wide base and straight lateral borders of pronotum.

DESCRIPTION

Measurements. Length: 2.1-2.2mm; width: 1.0-1.05mm. Ratios: Width pronotum/head: 1.48-1.49; width/length of pronotum: 1.50-1.54; width base/apex of pronotum: 1.54-1.55; width widest diameter/base of pronotum: 0.97-0.98; length/width of elytra: 1.30-1.31.

Colour. Head and and posterior 2/3 of elytra dark piceous, pronotum, anterior third of elytra, suture, and apex slightly lighter, piceous to reddish-piceous. Elytra with a well-defined, contrasting, oblique, s-shaped, dark yellow or light reddish fascia in posterior 2/5 medially reaching 2nd stria. Sometimes the median, slightly widened part of the fascia isolated. Legs yellowish.

Head. Median antennomeres c. 1.3 x as long as wide. Microreticulation absent except from labrum and anterior border of clypeus, there about isodiametric. Surface glossy.

Pronotum. Moderately transverse, markedly convex, widest immediately at base, base much wider than apex. Lateral margin strongly and

evenly curved, posteriorly straight, not oblique. Posterior angles rectangular, feebly produced over lateral part of base. Carina at posterior angle elongate, oblique, slightly incurved, markedly raised. Anterior transverse sulcus deep, slightly interrupted by a fovea. Posterior transverse sulcus very deep, interrupted by a very large, deep fovea. Anterior lateral seta situated slightly behind anterior third of margin. Microreticulation completely absent, surface highly glossy.

Elytra. Short, highly convex, egg-shaped, widest about in middle. Lateral border evenly curved, extremely finely serrate and pilose. Sutural stria crenulate. Other striae well developed as rows of fairly coarse punctures, though laterally becoming finer. 2nd and 3rd striae in anterior half even faintly impressed. All striae traceable to apex. Sutural interval and basal part of 2nd interval somewhat convex. 8th stria deeply impressed throughout, punctate, surpassing posterior marginal pore. Recurrent striae rather evenly curved, meeting end of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior third. Microreticulation completely absent, surface highly glossy. Wings slightly shortened. Little variation noted.

Lower surface. Metepisternum slightly longer than wide.

Male genitalia. Genital ring triangular, slightly asymmetrical, apex rather elongate. Aedeagus rather short and compact, lower surface feebly curved, apex short, widely rounded off. Internal sac near apex with a sclerotized piece either at bottom or at roof, according to the degree of eversion of internal sac. Left paramere with 5 setae, right paramere apparently 4-setose.

Female genitalia. Stylomere 2 with dorsal ensiform seta situated rather medially.

DISTRIBUTION

Lowland at eastern foot of Bellenden Ker Range, north Queensland.

HABITAT

A lowland species, found in "palm swamp" and lowland rainforest on mossy tree trunks by pyrethrum knockdown and Berlese extraction. Collected October-November.

ETYMOLOGY

Refers to the occurrence at low elevation only.

Rainforest Zones

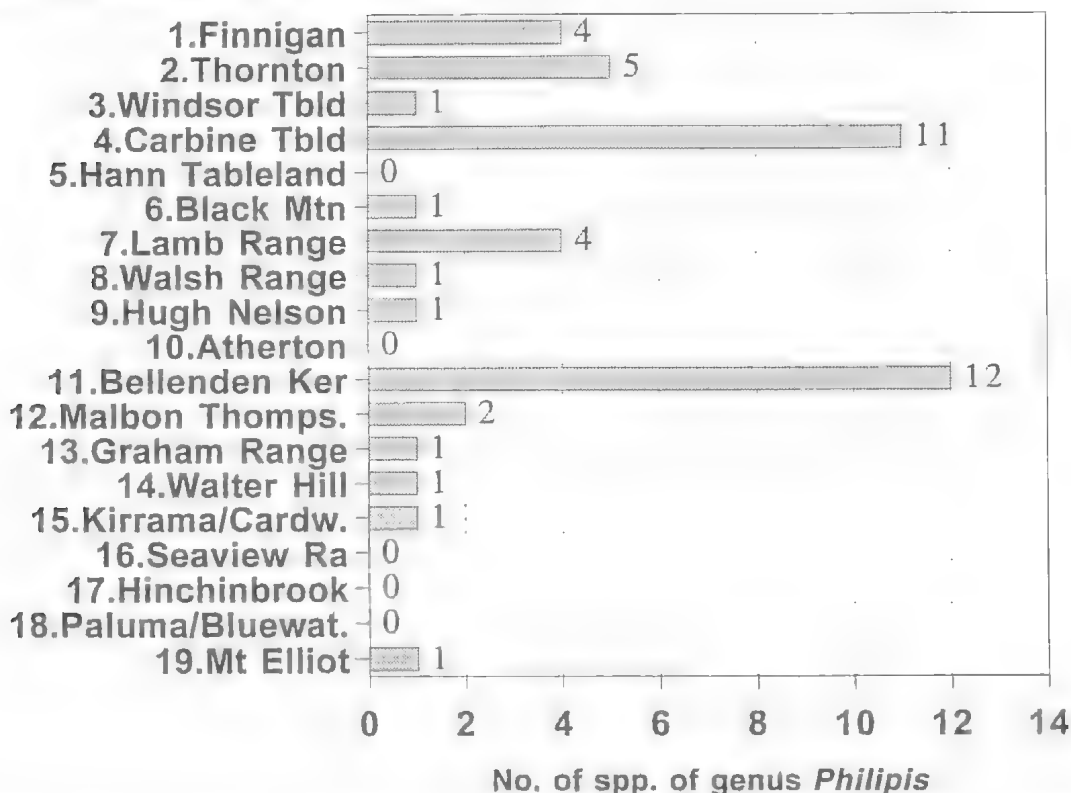


FIG. 10. Species numbers of genus *Philipis* in the north Queensland mountain/rainforest blocks. For explanation see text.

Philipis spurgeoni sp. nov. (Figs 13C, 18C)

MATERIAL EXAMINED

HOLOTYPE: QMT13569; ♀, 16°24'S, 145°13'E, 3.5km NNE Mt. Spurgeon, NEQ, 16 Oct 1991, 1330m, Monteith & Janetzki, Pyrethrum, trees & rocks.

DIAGNOSIS

Medium sized, convex, with s-shaped fascia in posterior half of elytra. Distinguished by larger size, narrower base of elytra, and presence of microreticulation on elytra.

DESCRIPTION

Measurements. Length: 2.28mm; width: 1.08mm. Ratios: Width pronotum/head: 1.55; width/length of pronotum: 1.54; width base/apex of pronotum: 1.44; width widest diameter/base of pronotum: 1.07; length/width of elytra: 1.30.

Colour. Dark piceous, apex of elytra and posterior part of suture faintly lighter. Elytra with a fairly well delimited, moderately conspicuous, oblique, rather s-shaped, light reddish fascia in posterior 2/5 medially reaching 2nd stria. Legs light reddish.

Head. Median antennomeres c. 1.2 x as long as wide. Microreticulation distinct on labrum and anterior border of clypeus, posteriorly moderately superficial, about isodiametric. Surface glossy.

Pronotum. Transverse, convex, widest about in middle, base much wider than apex, lateral margin posteriorly almost straight, slightly oblique. Base slightly narrower than widest diameter. Posterior angles rectangular, feebly produced over lateral part of base. Carina at posterior angle elongate, rather oblique, slightly incurved. Anterior transverse sulcus rather deep, not interrupted. Posterior transverse sulcus very deep, interrupted by a fovea. Anterior lateral seta situated

well behind anterior third of margin. Microreticulation absent, surface highly glossy.

Elytra. Short, convex, egg-shaped, widest about in middle. Lateral border evenly curved, extremely finely serrate and pilose. Sutural stria crenulate. 2nd stria gently impressed, even 3rd-5th striae very faintly impressed in anterior half. Striae moderately punctate, 2nd slightly crenulate. Outer striae traceable in anterior half as rows of fine punctures. Inner four striae just visible at apex. Sutural interval convex throughout, 2nd interval in basal half faintly convex. 8th stria deeply impressed, punctate-crenulate, attaining posterior marginal pore. Recurrent striae rather oblique, meeting position of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior third. Microreticulation distinct, though somewhat superficial, composed of slightly transverse meshes. Surface rather glossy, but markedly less glossy than prothorax. Wings slightly shortened. Variation unknown.

Lower surface. Metepisternum slightly longer than wide.

Genitalia. Male unknown. Female stylomere 2 with very stout dorsal ensiform seta situated rather basally.

DISTRIBUTION

Mt. Spurgeon area, Carbine Tableland, north Queensland. Known only from type locality.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks and rocks in montane rainforest above 1300m. Collected only October.

ETYMOLOGY

Refers to the type locality, Mt. Spurgeon.

***Philipis trunci* (Darlington)**
(Figs 5D, 13D, 18C)

Tachys trunci Darlington, 1963: 31.

Philipis trunci, Erwin 1994: 568.

MATERIAL EXAMINED

HOLOTYPE: M.C.Z. Type No.30335; ♂, Mt. Alexandra, Thornton Peak Natl. Park, QLD, Dec. 197 (MCZ). **ADDITIONAL MATERIAL:** 10 ♂, 6 ♀, Thornton Peak via Daintree, NEQ, 1000-1300m, 20-22 Sept 1981, GM & DC (ANIC, CBM, QM, USNM, ZSM); 1 ♂, Thornton Peak via Daintree, NEQ, 20-22 Sept 1981, GM & DC, QM Berlesate No. 301, RF, 1000-1300m, sieved litter & moss (QM); 2 ♂, 1 ♀, Thornton Peak, 11 km NE Daintree, NEQ, 1 Nov 1983, GM, DY & GT, QM

Berlesate No.605, 16°10S, 145°22E, RF, 1100m, moss on rocks & trees (QM).

DIAGNOSIS

Small, convex, with s-shaped fascia in posterior half of elytra. Distinguished by deeply impressed 1st and 2nd striae and by outer striae almost absent.

DESCRIPTION

Measurements. Length: 2.0-2.25mm; width: 0.95-1.03mm. Ratios: Width pronotum/head: 1.51-1.56; width/length of pronotum: 1.51-1.53; width base/apex of pronotum: 1.38-1.44; width widest diameter/base of pronotum: 1.09-1.13; length/width of elytra: 1.28-1.31.

Colour. Dark piceous, apex of elytra and posterior part of suture faintly lighter. Elytra with a rather ill delimited, inconspicuous, oblique, more or less s-shaped, light reddish fascia in posterior 2/5 medially reaching almost to 2nd stria. Legs reddish.

Head. Median antennomeres c. 1.3 x as long as wide. Microreticulation distinct on labrum and anterior border of clypeus, extremely superficial and very difficult to see on frons, absent on vertex, about isodiametric. Surface highly glossy.

Pronotum. Transverse, convex, widest about in middle, base much wider than apex. Lateral margin posteriorly almost straight, slightly oblique, even extremely faintly concave in front of posterior angles. Posterior angles rectangular, feebly produced over lateral part of base. Carina at posterior angle elongate, markedly oblique, slightly incurved. Anterior transverse sulcus rather deep, barely interrupted. Posterior transverse sulcus very deep, interrupted by a very large, deep fovea. Anterior lateral seta situated slightly behind anterior third of margin. Microreticulation absent, surface highly glossy.

Elytra. Short, highly convex, egg-shaped, widest about in middle. Lateral border evenly curved, extremely finely serrate and pilose. Sutural stria crenulate. 2nd stria beginning well behind base, punctate, almost as deeply impressed as sutural stria. 3rd-5th striae absent or indicated in anterior half only as extremely inconspicuous rows of very fine punctures, outer striae completely absent. Only sutural stria visible at apex. Sutural interval and basal half or 2/3 of 2nd interval convex. 8th stria deeply impressed, punctate-crenulate, barely attaining posterior marginal pore. Recurrent striae rather oblique, meeting end of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior

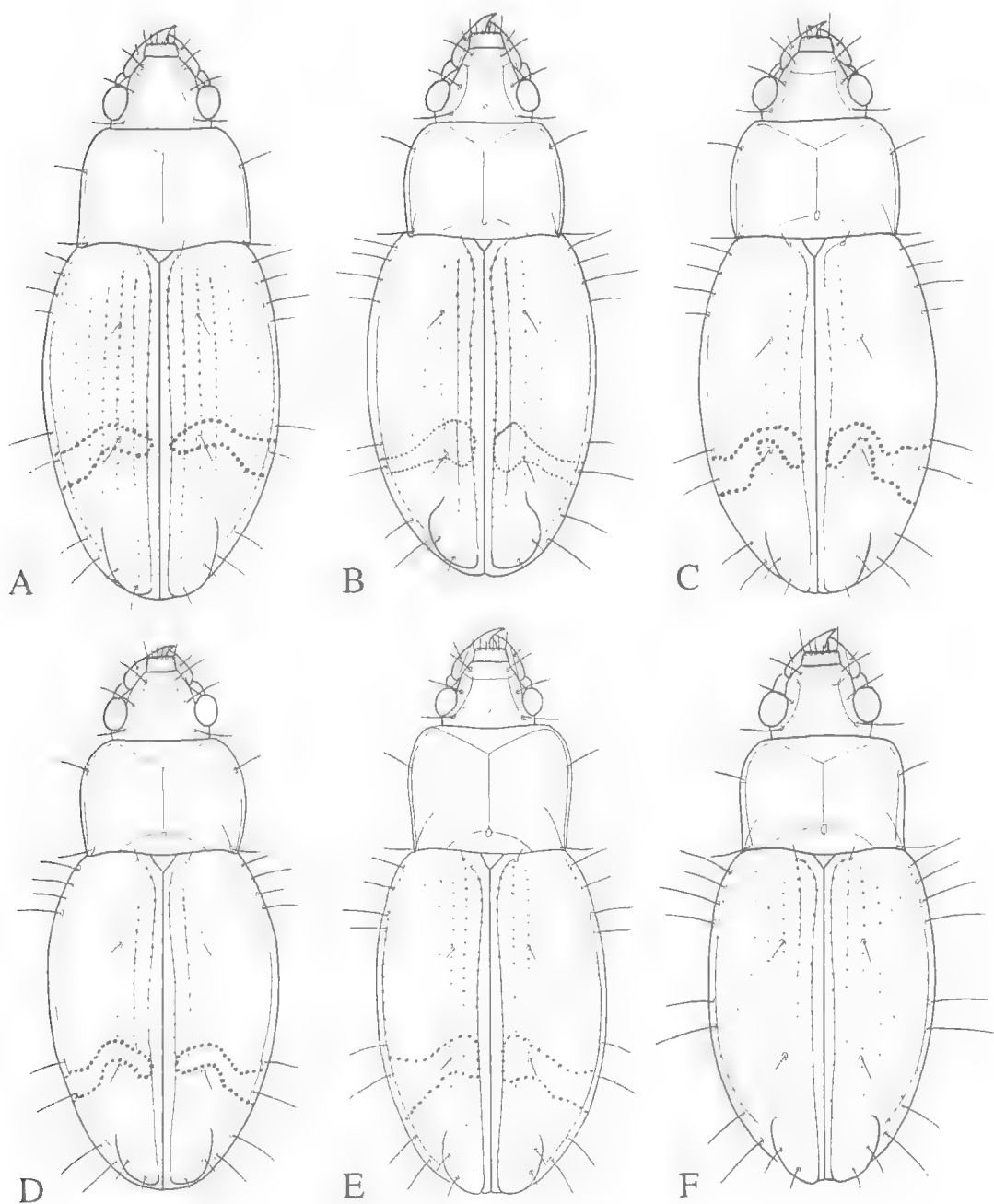


FIG. 11. Habitus. A, *Philipis quadraticollis* sp. nov. B, *P. alticola* sp. nov. C, *P. cooki* sp. nov. D, *P. laevigata* sp. nov. E, *Philipis heatherae* sp. nov. F, *P. picea* sp. nov. Lengths: 2.7mm; 2.75mm; 2.6mm; 2.2mm; 2.35mm; 2.5mm.

third. Microreticulation on disk extremely superficial, hardly visible, composed of transverse meshes; or absent. Surface highly glossy. Wings shortened.

Lower surface. Metepisternum slightly longer than wide.

Male genitalia. Genital ring triangular, narrow, rather asymmetric, apex narrow. Aedeagus moderately elongate, lower surface straight or faintly bisinuate in basal 2/3, in apical third slightly curved down, apex moderately elongate, widely rounded off. Internal sac near apex with moderately distinct triangular fold. Parameres rather elongate, both 5-setose.

Female genitalia. Stylomere 2 with very stout dorsal ensiform seta situated rather basally.

Variation. Generally little variation noted, apart from some differences in distinctness of the elytral fascia which is in one specimen even almost invisible. One specimen, however, differs in following respects; base of pronotum narrower than usual (ratio width base/apex 1.38 compared with 1.43-1.44 as usual); 2nd stria far less impressed than usual; oblique fascia on elytra more contrasting than usual.

DISTRIBUTION

Thornton Peak north of Daintree, north Queensland. Known only from this mountain top.

HABITAT

Collected by pyrethrum knockdown and Berlese extraction of mossy tree trunks and rocks in montane rainforest above 1000m. The unique type was collected "on the trunk of a small tree in rainforest at probably about 3,000 ft. altitude". Collected September, November, and December.

Philipis tribulationis sp. nov.

(Figs 5E, 13E, 18C)

MATERIAL EXAMINED

HOLOTYPE: QMT13570; ♂, 4.0km W of Cape Tribulation (Site 8), NEQ, 28 Sept 1982, 720m, Monteith, Yeates & Thompson, Pyrethrum knockdown, RF.

PARATYPES: 2 ♂, 3.5km W of Cape Tribulation (Site 7), NEQ, 2 Oct 1982, 680m, GM, DY & GT, Pyr., RF (QM); 1 ♂, 1 ♀, 4.5-5.0km W. of Cape Tribulation (Top Camp), NEQ, 1-6 Oct 1982, 760-780m, GM, DY & GT, Pyr., RF (CBM, QM); 1 ♀, 16°04'S, 145°24'E, Mt Pieter Botte, NEQ, 950m, 21 Nov 1993, GM & HJ, Pyr./trees, logs, rocks (QM); 4 ♂, 16°03'S, 145°25'E, Mt Haleyon, NEQ, 870m, 23 Nov 1993, GM & HJ, Pyr./trees & logs (ANIC, CBM, QM); 1 ♀, Windsor Tableland, NEQ, 9 Jan 1989, 1225m, ES & ANZSES Site 3, Pyr. (QM).

DIAGNOSIS

Small, convex, with s-shaped fascia on posterior half of elytra. Distinguished by 2nd stria less impressed than 1st, smaller size, and rather narrow base of pronotum.

DESCRIPTION

Measurements. Length: 1.95-2.14mm; width: 0.92-0.98mm. Ratios: Width pronotum/head: 1.48-1.54; width/length of pronotum: 1.50-1.53; width base/apex of pronotum: 1.40-1.42; width widest diameter/base of pronotum: 1.08-1.11; length/width of elytra: 1.31-1.33.

Colour. Dark piceous, pronotum, basal third and apex of elytra slightly lighter, posterior half of suture even lighter, reddish-piceous. Elytra with a well-defined, contrasting, oblique, s-shaped, dark yellow or light reddish fascia in posterior 2/5 medially reaching 2nd stria. Legs yellow.

Head. Frons anteriorly somewhat uneven. Median antennomeres c. 1.3 x as long as wide. Microreticulation distinct on labrum and anterior border of clypeus, very superficial and difficult to see on frons, absent on vertex, about isodiametric. Surface glossy.

Pronotum. Rather transverse, convex, widest about in middle, base much wider than apex. Lateral margin evenly curved, though posteriorly less so than towards apex. Posterior angles rectangular or even slightly acute, feebly produced over lateral part of base. Carina at posterior angle elongate, oblique, slightly incurved. Anterior transverse sulcus rather deep, slightly interrupted by a fovea. Posterior transverse sulcus very deep, interrupted by a large, deep fovea. Anterior Lateral seta situated slightly behind anterior third of margin. Microreticulation absent, surface highly glossy.

Elytra. Short, highly convex, egg-shaped, widest about in middle. Lateral border evenly curved, extremely finely serrate and pilose. Sutural stria crenulate. Other striae well developed as rows of fairly coarse punctures, though becoming finer laterally and posteriorly. 2nd and 3rd striae in anterior half even faintly impressed. At least inner striae traceable to apex. Sutural interval and basal part of 2nd interval somewhat convex. 8th stria deeply impressed, punctate-crenulate, barely attaining posterior marginal pore. Recurrent striae rather evenly curved, meeting end of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior third. Microreticulation transverse, on disk strongly reduced and extremely superficial, even under high

magnification almost invisible, slightly better seen near apex. Surface rather glossy. Wings shortened.

Lower surface. Metepisternum barely longer than wide.

Male genitalia. Genital ring triangular, rather asymmetric, especially at base, apex rather elongate. Aedeagus moderately elongate, lower surface basally straight, feebly curved to apex, apex fairly short, widely rounded off. Both parameres 5-setose.

Female genitalia. Stylomere 2 with dorsal ensiform seta situated rather medially.

Variation. Apart from some differences of size and relative width of pronotum, very little variation noted.

DISTRIBUTION

Mountains some kilometers west of Cape Tribulation to Windsor Tableland, north Queensland.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks in montane rainforest between 680 and 1200m. Collected September–October and January.

ETYMOLOGY

Refers to the type locality, the vicinity of Cape Tribulation.

Philipis thompsoni sp. nov.
(Figs 2, 5F, 13F, 17B)

MATERIAL EXAMINED

HOLOTYPE: QMT13578; ♂, Hugh Nelson Ra., 2.5km S. of Crater N.P., NQ, 5 Dec 1988, 1100m, Monteith & Thompson, pyrethrum/logs & trees.

PARATYPES: 3 ♂, 2 ♀, 1 (?sex), same data (CBM, QM); 1 ♂, 1 ♀, Mt. Fisher, 7km SW Millaa Millaa, NQ (Whiteing Rd), 5 May 1983, 1200m, GM, DY, RF, Pyr. (QM); 2 ♂, Mt. Edith, Lamb Range, NEQ, 12 Oct 1982, 1000–1100m, GM, DY & GT, Pyr., RF (QM); 1 ♀, Emerald Ck, Lamb Range, NEQ, 11 Oct 1982, 950m, GM, DY & GT, Pyr., RF (CBM); 1 ♂, 1 ♀, 21km S Atherton, NEQ, 1040–1100m, 5 Nov 1983, DY & GT, Pyr., RF (CBM, QM); 1 ♀, Baldy Mtn Rd, 7 km SW Atherton, NEQ, 9 Dec 1988, 1150m, GM & GT, Pyr./logs & trees (QM); 1 ♂, 1 ♀, Mt. Father Clancy, 9 km S Millaa Millaa, NEQ, 6 Dec 1988, 1000m, GM & GT, Pyr./logs & trees (QM); 3 ♂, Mt. Formartine South, 10km N Kuranda, NEQ, 23 Nov 1990, 700m, GM & GT, Pyr./trees & logs (QM); 1 ♂, 1 ♀, 16°55'S, 145°40'E, Mt. Williams, NEQ, 900–1000m, 2–3 Dec 1993, DC, GM & HJ (QM); 1 ♂, 1 ♀, 17°03'S, 145°42'E, Isley Hills, NEQ, 1050m, 30 Nov 1993, GM & HJ, Pyr./trees & logs (QM); 1 ♂, 17°16'S, 145°49'E, Massey Range, 4km W of Centre Bellenden Ker, NEQ,

9–11 Oct 1991, 1250m, GM, HJ & DC (QM); 1 ♂, Mt. Bartle Frere, NEQ, West Side, 1050m, 8 Dec 1990, GM, GT & RS, Pyr./trees & rocks (QM); 1 ♀, 1 (sex?), Upper Boulder Ck. via Tully, NEQ, 900m, 26 Oct 1983, GM, DY & GT, Pyr., RF (QM); 6 ♂, 3 ♀, Upper Boulder Creek, 11km N Tully, NEQ, 5 Dec 1989, 1000m, GM, GT, HJ, Pyr./logs & trees (ANIC, CBM, QM, USNM, ZSM); 2 ♂, 1 ♀, Tully Falls, NEQ, 8 Dec 1990, 750m, GM, GT, HJ, Pyr., logs & trees (CBM, QM); 2 ♀, Cardwell Range, NEQ, Mt Macalister area, 1000m, 19 Dec 1986, GM, GT & SH, Pyr. (QM).

DIAGNOSIS

Medium sized, convex, with s-shaped fascia in posterior half of elytra. Distinguished by larger size, wide base of elytra, absence of microreticulation on elytra and shorter aedeagus with almost straight lower surface.

DESCRIPTION

Measurements. Length: 2.15–2.30mm; width: 1.0–1.1mm. Ratios: Width pronotum/head: 1.51–1.55; width/length of pronotum: 1.46–1.52; width base/apex of pronotum: 1.45–1.49; width widest diameter/base of pronotum: 1.08–1.11; length/width of elytra: 1.33–1.34.

Colour. Dark piceous, apex of elytra and posterior part of suture, commonly also base of elytra faintly lighter. Elytra with a fairly well delimited, moderately conspicuous, oblique, more or less s-shaped, light reddish fascia in posterior 2/5 medially reaching 2nd stria. Legs reddish.

Head. Median antennomeres c. 1.3 x as long as wide. Microreticulation distinct on labrum and anterior border of clypeus, highly superficial, but discernible at high magnification on frons, absent on vertex, about isodiametric. Surface glossy.

Pronotum. Transverse, convex, widest about in middle, base much wider than apex. Lateral margin evenly curved, though posteriorly sometimes almost straight, slightly oblique. Posterior angles rectangular, feebly produced over lateral part of base. Carina at posterior angle elongate, markedly oblique, slightly incurved. Anterior transverse sulcus rather deep, not interrupted. Posterior transverse sulcus very deep, barely interrupted. Anterior lateral seta situated well behind anterior third of margin. Microreticulation absent, surface highly glossy.

Elytra. Short, highly convex, egg-shaped, widest about in middle. Lateral margin evenly curved, extremely finely serrate and pilose. Sutureal stria crenulate. 2nd stria well visible as a row of fairly distinct punctures, sometimes even faintly impressed in anterior half. Outer striae traceable at least in anterior half as fine rows of

punctures. Only sutural stria visible at apex. Sutural interval convex, sometimes also 2nd interval in basal half faintly convex. 8th stria deeply impressed, punctate-crenulate, clearly attaining posterior marginal pore. Recurrent striole rather oblique, meeting end of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior third. In males microreticulation on disk extremely superficial and hardly visible, or absent, in most females microreticulation slightly more distinct, composed of transverse meshes. Surface in males highly glossy, in females usually slightly less glossy. Wings slightly shortened.

Lower surface. Metepisternum slightly longer than wide.

Male genitalia. Genital ring triangular, narrow, rather asymmetric, apex narrow. Aedeagus moderately elongate, lower surface straight in basal 2/3, in apical third feebly curved down, apex moderately elongate, widely rounded off. Internal sac near apex with very distinct triangular fold. Parameres rather short, both 5-setose.

Female genitalia. Stylomere 2 with very stout dorsal ensiform seta situated rather basally.

Variation. Due to the wide range of this species, some variation of colour, distinctness of pattern, shape of pronotum, and degree of microreticulation and striation of elytra noted.

DISTRIBUTION

A widely distributed species from the Kuranda area, the Lamb Range, mountains surrounding the Atherton Tableland, and south to the Cardwell Range, north Queensland.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks and logs in montane rainforest above 700m. Collected October–December and May.

ETYMOLOGY

Named in honour of Geoff Thompson, collector of many specimens of *Philipis*.

Philipis vicina sp. nov.
(Figs 6A, 14A, 17B)

MATERIAL EXAMINED

HOLOTYPE: QMT13612; ♂, Mt Misery Summit via Helenvale, NEQ, 6 Dec 1990, 850m, Monteith, Sheridan & Roberts, Pyrethrum-trees & logs.

DIAGNOSIS

Medium sized, convex, with s-shaped fascia in posterior half of elytra. Distinguished by larger

size, narrower base of elytra, absence of microreticulation on elytra, and longer aedeagus with bisinuate lower surface.

DESCRIPTION

Measurements. Length: 2.20mm; width: 1.00mm. Ratios: Width pronotum/head: 1.52; width/length of pronotum: 1.55; width base/apex of pronotum: 1.40; width widest diameter/base of pronotum: 1.10; length/width of elytra: 1.33.

Colour. Dark piceous, apex of elytra and posterior part of suture faintly lighter. Elytra with a fairly well delimited, moderately conspicuous, oblique, s-shaped, light reddish fascia in posterior 2/5 medially reaching 2nd stria. Legs light reddish.

Head. Median antennomeres c. 1.2 x as long as wide. Microreticulation distinct on labrum and anterior border of clypeus, posteriorly superficial, about isodiametric. Surface glossy.

Pronotum. Transverse, convex, widest about in middle, base much wider than apex. Lateral margin posteriorly almost straight, slightly oblique. Base little narrower than widest diameter. Posterior angles rectangular, feebly produced over lateral part of base. Carina at posterior angles elongate, rather oblique, slightly incurved. Anterior transverse sulcus rather deep, not interrupted. Posterior transverse sulcus very deep, interrupted by a fovea. Anterior lateral seta situated well behind anterior third of margin. Microreticulation absent, surface highly glossy.

Elytra. Short, convex, egg-shaped, widest about in middle. Lateral border evenly curved, extremely finely serrate and pilose. Sutural stria crenulate. 2nd stria faintly impressed in anterior half. 3rd–5th striae well visible as rows of moderately fine punctures, outer striae traceable in anterior half as rows of fine punctures. Inner four striae just visible at apex. Sutural interval convex throughout, 2nd interval in basal half faintly convex. 8th stria deeply impressed, punctate-crenulate, attaining posterior marginal pore. Recurrent striole elongate, rather oblique, meeting position of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior third. Microreticulation almost absent. Surface highly glossy. Wings slightly shortened. Variation unknown.

Lower surface. Metepisternum slightly longer than wide.

Genitalia. Male genital ring triangular, narrow, rather asymmetric, apex narrow. Aedeagus fairly elongate, lower surface perceptibly bisinuate in basal 2/3, in apical third feebly curved down,

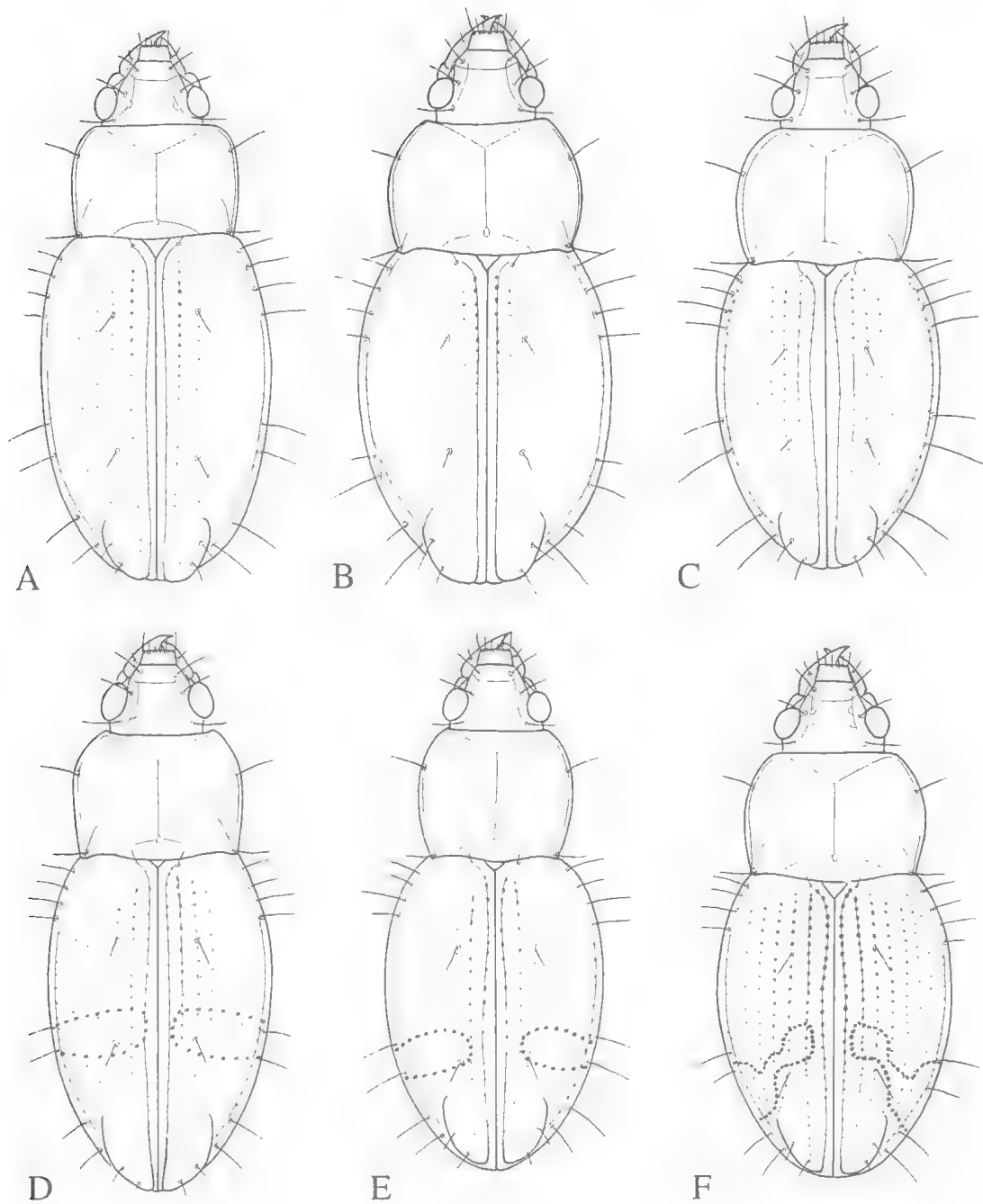


FIG. 12. Habitus. A, *P. castanea* sp. nov. B, *P. unicolor* sp. nov. C, *Philipis atra* sp. nov. D, *P. ruficollis* sp. nov. E, *P. inermis* sp. nov. F, *P. reticulata* sp. nov. Lengths: 2.35mm; 2.05mm; 2.45mm; 2.5mm; 1.95mm; 2.2mm.

apex rather elongate, widely rounded off. Internal sac near apex with very distinct triangular fold. Parameres rather elongate, both 5-setose. Female genitalia unknown.

DISTRIBUTION

Mt. Misery south of Helenvale, north Queensland. Known only from type locality.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks and logs in montane rainforest above 850m. Collected December only.

ETYMOLOGY

Refers to the very close relationships of this species with *P. thompsoni* and *P. spurgeoni*.

Philipis laevis sp. nov.
(Figs 6B, 14B, 17B)

MATERIAL EXAMINED

HOLOTYPE: QMT13613; ♂, Thornton Peak via Daintree, NEQ, 1000-1300m, 20-22 Sept 1981, G. Monteith & D. Cook.

PARATYPES: 2 ♀, same data (QM); 7 ♂, 6 ♀, Thornton Peak summit, via Daintree, NEQ, 24-27 Sept 1984, GM & SM, QM Berlesate NO. 662, RF, 1100-1300m, sieved litter & moss (ANIC, CBM, QM, USNM, ZSM).

DIAGNOSIS

Small, short, convex, easily identified by quadrimaculate pattern, absence of all elytral striae apart from 1st, and highly glossy surface.

DESCRIPTION

Measurements. Length: 2.05-2.30mm; width: 1.04-1.12mm. Ratios: Width pronotum/head: 1.58-1.62; width/length of pronotum: 1.43-1.49; width base/apex of pronotum: 1.41-1.45; width widest diameter/base of pronotum: 1.12-1.15; length/width of elytra: 1.24-1.28.

Colour. Head and pronotum dark piceous, elytra slightly lighter, piceous or reddish-piceous. Elytra with two rather ill-defined spots, a larger, about triangular one at outer angle of shoulder, and a smaller, narrower, fascia-like one behind middle, extending from border to position of 3rd stria. Legs reddish to reddish-brown, apex of femora and tibiae, and tarsi yellow.

Head. Median antennomeres c. 1.75 x as long as wide. Microreticulation well visible only on librum and anterior half of clypeus, extremely superficial and hardly recognizable on anterior

part of frons, absent on rest of head, about isodiametric. Surface highly glossy.

Pronotum. Rather convex, transverse, widest about in middle, base much wider than apex. Lateral margin strongly and evenly curved, though more to apex than to base. Posterior angles rectangular, distinctly produced over lateral part of base. Carina at posterior angle comparatively short, oblique, slightly incurved. Anterior transverse sulcus deep, uninterrupted. Posterior transverse sulcus very deep, interrupted by a large fovea. Anterior lateral seta situated slightly behind anterior third of margin. Microreticulation absent, surface highly glossy.

Elytra. Short and wide, highly convex, widest in middle, lateral border evenly curved. Sutural stria in anterior half slightly punctulate, posteriorly smooth. Other striae absent, but sometimes 2nd stria in basal half faintly indicated as a row of delicate punctures. Only sutural interval convex. 8th stria deeply impressed, barely punctate, not attaining posterior marginal pore. Recurrent striae rather short, close to lateral border and markedly oblique, anteriorly suddenly incurved, hardly meeting position of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly behind posterior 2/5. Microreticulation absent, surface highly glossy. Wings extremely shortened.

Lower surface. Metepisternum about as long as wide.

Male genitalia. Genital ring slightly asymmetrical, apex rather acute. Aedeagus short and compact, lower surface to apex slightly curved. Apex short, rounded off. Both parameres 5-setose.

Female genitalia. Stylocere 2 with very stout dorsal ensiform seta situated about medially.

Variation. Apart from some minor differences in size, relative shape of pronotum, and degree of 2nd stria of elytra, little variation noted.

DISTRIBUTION

Thornton Peak north of Daintree, north Queensland. Known only from this mountain top.

HABITAT

Collected in montane rainforest above 1000m by Berlese extraction from litter and moss. Collected September.

ETYMOLOGY

Refers to the remarkably smooth and glossy surface of elytra.

***Philipis sulcata* sp. nov.**
(Figs 6C, 14C, 18D)

MATERIAL EXAMINED

HOLOTYPE: QMT13624; ♂, nr. Plane Crash Site, 11km NW Mossman, NEQ, 28 Dec 1989, 1240m, ANZSES, Pyrethrum.

PARATYPES: 2 ♂, 1 ♀, same data (CBM, QM); 2 ♀, Pauls Luck, Platypus Ck, 13km W Mossman, NEQ, 1-2 Jan 1990, 1100m, ANZSES, Pyr. (QM); 2 ♂, 1 ♀, Mossman Bluff Summit 10km W Mossman, NEQ, 18 Dec 1988, 1300m, GM & GT, Pyr. trees & rocks (QM, USNM); 1 ♂, Mossman Bluff Track 6km W Mossman, NEQ, 16 Dec 1988, 480m, GM & GT, Pyr. trees & rocks (QM); 5 ♀, Devil's Thumb 12km NW Mossman, NEQ, 27 Dec 1989, 1000m, ANZSES, Pyr. (ANIC, CBM, QM, ZSM).

DIAGNOSIS

Small to medium sized, highly convex, easily identified by the fully and deeply striate elytra, the elongate, on lower surface near apex strongly sinuate aedeagus with elongate apex, and the elongate, parallel parameres; further distinguished from *P. perstriata* sp. nov. by wider elytra, absence of microreticulation on the elytra, and shorter apical elytral spot.

DESCRIPTION

Measurements. Length: 2.05-2.5mm; width: 0.95-1.2mm. Ratios: Width pronotum/head: 1.58-1.64; width/length of pronotum: 1.53-1.57; width base/apex of pronotum: 1.48-1.57; width widest diameter/base of pronotum: 1.11-1.15; length/width of elytra: 1.27-1.31.

Colour. Dark piceous, pronotum and posterior half of suture slightly lighter, in light specimens pronotum even dark reddish. Behind shoulder and in posterior 2/5 of elytra with a rather inconspicuous, slightly transverse, yellowish spot each, both attaining about 4th stria. Both spots moderately conspicuous and not well delimited. Pores on 3rd stria encircled by a small yellowish spot. Legs dark yellow.

Head. Very short and wide, neck very wide, separated from frons by a shallow impression. Median antennomeres barely longer than wide. Microreticulation distinct on whole surface, even on vertex, though somewhat superficial, about isodiametric to slightly transverse. Surface rather dull.

Pronotum. Transverse, convex, widest about in middle or slightly in front of it, base much wider than apex. Lateral margin posteriorly but feebly convex, fairly oblique. Posterior angles rectangular, barely produced over lateral part of base. Carina at posterior angle very elongate, mark-

edly oblique, slightly incurved. Anterior transverse sulcus deep, not interrupted. Median line rather deeply impressed. Posterior transverse sulcus very deep, interrupted by a rather large fovea. Anterior lateral seta situated well behind anterior third of margin, Microreticulation very superficial or almost absent, surface glossy.

Elytra. Very short and convex, egg-shaped, widest about in middle, Lateral border evenly curved, not perceptibly serrate and pilose. All striae deeply impressed, sulcate, and crenulate till apex. All intervals markedly convex along their whole course. 8th stria deeply impressed, anteriorly barely shallower, crenulate, attaining posterior marginal pore. Recurrent striae elongate, markedly oblique, anteriorly suddenly incurved, meeting 3rd stria. Anterior discal pore well behind anterior third, posterior pore very close to anterior pore, shortly behind middle. Both pores very large, foveiform, interrupting 3rd interval. Microreticulation highly superficial to almost absent, moderately transverse. Surface rather glossy. Wings extremely shortened.

Lower surface. Metepisternum c. 1.2 x as long as wide.

Male genitalia. Genital ring triangular, rather asymmetric, moderately wide, apex narrow. Aedeagus fairly elongate, lower surface conspicuously bisinuate near apex, apex elongate, far protruding, curved, fairly wide and widely rounded off. Parameres elongate, right narrow, both with 5 unusually short setae of which only the most apical seta is rather elongate, at or near apex.

Female genitalia. Stylomere 2 with stout dorsal ensiform seta situated rather medially.

Variation. Apart from some minor differences in colour, relative shape of pronotum, and degree of microreticulation on pronotum and elytra, little variation noted. However, there is one perhaps not fully coloured and somewhat deformed specimen that shows more distinct aberrations in shape and microsculpture: it has a remarkably rough surface of the elytral intervals, and strongly crenulate striae. However, this may be due to some creasing of the elytra shortly after emerging.

DISTRIBUTION

Mountains of the Carbine Tableland west of Mossman, north Queensland.

HABITAT

Collected by pyrethrum knockdown on mossy trees and rocks in montane rainforest, usually

above 1100m, but one record just below 500m. Collected December and January.

ETYMOLOGY

Refers to the deeply sulcate elytral striation.

Philipis frerei sp. nov.
(Figs 6D, 14D, 18D)

MATERIAL EXAMINED

HOLOTYPE: QMT13634; ♂, Mt. Bartle Frere, NEQ, 0.5km N of Sth. Peak, 6-8 Nov 1981, 1500m, Earth-watch/Qld. Museum pyrethrum knockdown.

PARATYPES: 1 ♂, 6 ♀, Mt. Bartle Frere, NEQ, Sth. Peak Summit, 1620m, 6-8 Nov 1981, EW/QM Pyr. (ANIC, CBM, QM, ZSM); 1 ♀, Mt. Bartle Frere, summit creek, NEQ, 24 Sept 1981, GM & DC, QM Berlesate No. 304, RF, 1500m, sieved litter (QM); 1 ♂, 1 ♀, Mt. Bartle Frere, NEQ, Central Ridge, 1500m, 27 Dec 1989, GM, Pyr., logs (CBM, QM).

DIAGNOSIS

Medium sized, quadrimaculate, with reddish pronotum and transverse apical elytral spot, distinguished from similarly patterned species by almost fully striate elytra, very weak microreticulation on the elytra, small aedeagus with elongate apex, and 4-setose parameres.

DESCRIPTION

Measurements. Length: 2.05-2.45mm; width: 1.0-1.15mm. Ratios: Width pronotum/head: 1.60-1.64; width/length of pronotum: 1.44-1.51; width base/apex of pronotum: 1.42-1.48; width widest diameter/base of pronotum: 1.11-1.19; length/width of elytra: 1.31-1.34.

Colour. Reddish-piceous, pronotum, apex and suture of elytra faintly lighter. Elytra at shoulder with a very inconspicuous, extremely ill delimited, about triangular, light reddish spot attaining about position of 4th stria. In posterior 2/5 of elytra with a moderately conspicuous, fairly well delimited, narrowly triangular, slightly oblique, light reddish spot or stripe, attaining about 3rd stria. Legs light reddish, tibiae sometimes faintly darker.

Head. Frons without median groove. Median antennomeres c. 1.2 x as long as wide. Microreticulation distinct and coarse on most of head, weaker only on vertex, about isodiametric to slightly transverse. Surface somewhat dull.

Pronotum. Transverse, moderately convex, widest about in middle, base much wider than apex. Lateral margin posteriorly moderately curved, rather oblique, at posterior angles faintly incurved. Base usually distinctly narrower than

widest part. Posterior angles fairly obtuse, slightly produced over lateral part of base. Carina at posterior angle moderately elongate, rather oblique, slightly incurved. Anterior transverse sulcus fairly deep, feebly interrupted. Posterior transverse sulcus deep, interrupted by large fovea. Anterior lateral seta situated slightly behind anterior third of margin. Microreticulation distinct, though superficial, almost isodiametric, surface moderately glossy.

Elytra. Rather short and convex, egg-shaped, widest slightly behind anterior third. Lateral border evenly curved, extremely finely, almost not perceptibly, serrate and pilose. 1st-3rd striae deeply impressed, punctate-crenulate. All other striae at least in basal half perceptibly impressed, though becoming shallower laterally and apically. All striae moderately finely punctate. 1st-4th intervals convex throughout, outer intervals convex only in basal half, becoming posteriorly rather depressed. All striae well visible at apex, though outer striae finer. 8th stria deeply impressed throughout, indistinctly punctate, attaining posterior marginal pore. Recurrent striae elongate, rather oblique, meeting 3rd stria. Anterior discal pore well behind anterior third, posterior pore well in front of posterior third. Microreticulation indistinct and highly superficial, consisting of irregular, rather transverse meshes. Surface glossy. Wings extremely shortened.

Lower surface. Metepisternum about as long as wide.

Male genitalia. Genital ring almost regularly triangular, wide, feebly asymmetric, apex rather narrow. Aedeagus very small, short and compact, lower surface in apical half strongly curved down, apex moderately short, widely rounded off. Parameres moderately elongate, both 4-setose.

Female genitalia. Stylomere 2 with stout dorsal ensiform seta situated rather medially.

Variation. Apart from some differences in relative shape of pronotum, little variation noted.

DISTRIBUTION

Mt. Bartle Frere, north Queensland. Known only from that mountain top.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks and logs, and by Berlese extraction of litter in montane rainforest above 1500m. Collected September, November, and December.

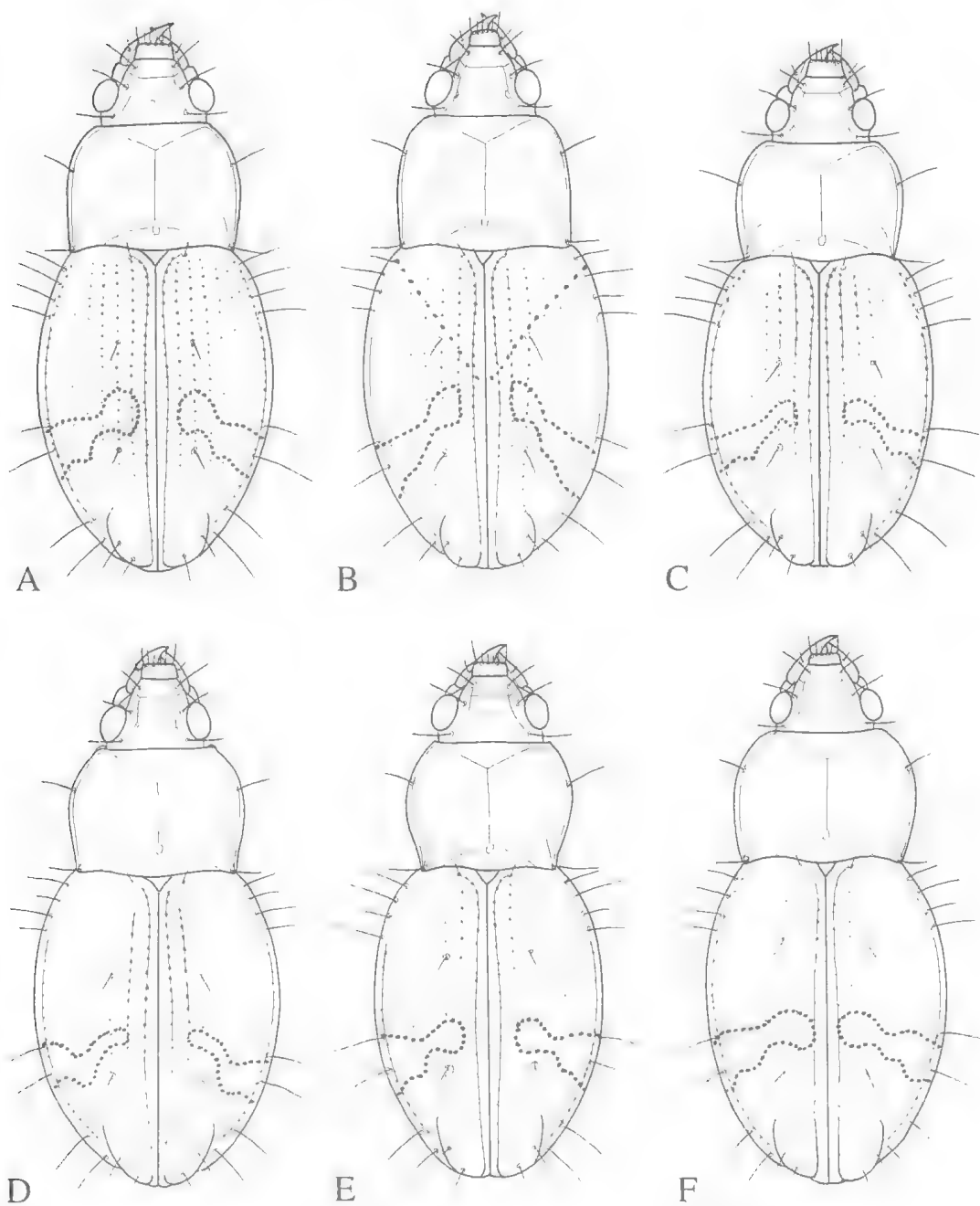


FIG. 13. Habitus. A, *Philipis striata* sp. nov. B, *P. planicola* sp. nov. C, *P. spurgeoni* sp. nov. D, *P. trunci* (Darlington). A, *Philipis tribulationis* sp. nov. B, *P. thompsoni* sp. nov. Lengths: 2.3mm; 2.1mm; 2.3mm; 2.1mm; 2.0mm; 2.25mm.

ETYMOLOGY

Refers to the type locality, Mt. Bartle Frere.

Philipis subtropica sp. nov.

(Figs 6E, 14E, 17A)

MATERIAL EXAMINED

HOLOTYPE: ♂, 28°14'S, 153°08'E Lamington N.P. (O'Reillys) Q, 22-27 Oct 1978, Lawrence & Weir, under bark rotten logs (ANIC).

PARATYPES: 1 ♀, same data (ANIC); 1 ♂, 28°16'S, 153°10'E Mt. Bithongabel, 1400m, Lamington Nat. Pk., Q, 23 Oct 1978, JL & TW, ANIC Berlesate 654, moss & litter *Nothofagus moorei* (CBM); 3 ♂, 3 ♀, 28°15'S, 153°16'E, Springbrook Repeater, 1000m, 16 Apr 1995, GM, Pyr. tree trunks (CBM, QM).

DIAGNOSIS

Medium-sized to large, quadrimaculate, with dark pronotum and transverse apical elytral spot, distinguished from similarly patterned species by absence of microreticulation on the elytra, presence of only 3 elytral striae, on lower surface evenly curved aedeagus with elongate, rather compact apex, and 5-setose parameres.

DESCRIPTION

Measurements. Length: 2.3-2.8mm; width: 1.0-1.25mm. Ratios: Width pronotum/head: 1.54-1.64; width/length of pronotum: 1.42-1.47; width base/apex of pronotum: 1.43-1.47; width widest diameter/base of pronotum: 1.13-1.15; length/width of elytra: 1.35-1.36.

Colour. Reddish-piceous, head slightly darker, apex of elytra and sometimes suture faintly lighter. Elytra at shoulder with an inconspicuous, ill delimited, about triangular, light reddish spot attaining about position of 5th stria. In posterior 2/5 of elytra with an equally ill delimited, transverse, yellowish spot, attaining about 2nd stria. Legs dark yellow to slightly infusate.

Head. Median antennomeres c. 1.3 x as long as wide. Microreticulation distinct on labrum and anterior part of clypeus, superficial on frons and vertex, about isodiametric to slightly transverse. Surface fairly glossy.

Pronotum. Rather transverse, fairly convex, widest slightly in front of middle, base much wider than apex. Lateral margin posteriorly almost straight, fairly oblique. Posterior angles rectangular, feebly produced over lateral part of base. Carina at posterior angle fairly elongate, moderately oblique, slightly incurved. Anterior transverse sulcus rather shallow, more or less distinctly interrupted. Posterior transverse sulcus fairly deep, becoming shallow in middle, though

without fovea. Anterior lateral seta situated well behind anterior third of margin. Microreticulation absent, surface highly glossy.

Elytra. Moderately short and convex, egg-shaped, widest slightly behind anterior third. Lateral border evenly curved, not perceptibly serrate and pilose. Sutural stria crenulate, 2nd stria in basal half just perceptible as a row of extremely fine and superficial punctures, outer striae absent. 1st interval convex, sometimes 2nd interval faintly convex near base. Only sutural stria traceable to apex. 8th stria deeply impressed, anteriorly shallower, punctate, though anteriorly smooth, just attaining posterior marginal pore, or interrupted shortly in front of it. Recurrent striae elongate, moderately oblique, meeting position of 3rd stria. Anterior discal pore well behind anterior third, posterior pore slightly in front of posterior third. Microreticulation absent. Surface highly glossy. Wings extremely shortened.

Lower surface. Metepisternum c. 1.2 x as long as wide.

Male genitalia. Genital ring very asymmetric, not triangular, wide, apex wide. Aedeagus rather large, fairly short and compact, lower surface concave, apex rather elongate, wide, protruding, widely rounded off. Internal sac within folded sclerite with a conspicuous, strongly sclerotized peg directed anteroventrally. Parameres moderately elongate, both 5-setose.

Female genitalia. Stylomere 2 with stout dorsal ensiform seta situated rather medially.

Variation. Some apparent sexual variation noted, since the few females tend to be markedly larger than the males. Also some variation in relative shape of the pronotum. Length of male genital ring and of aedeagus varies also to some degree.

DISTRIBUTION

Lamington Plateau and the adjacent Springbrook Plateau, southeast Queensland.

HABITAT

Collected in montane, temperate rainforest above 1000m under bark of rotten logs, by Berlese extraction from moss and litter of *Nothofagus*, and by pyrethrum knockdown on mossy tree trunks. Collected April and October.

ETYMOLOGY

Refers to the occurrence in subtropical latitude in south Queensland.

***Philipis alutacea* sp. nov.**
(Figs 6F, 14F, 18D)

MATERIAL EXAMINED

HOLOTYPE: QMT13641; ♂, Bellenden Ker, NEQ, summit, 10 June 1980, G. B. Monteith.

PARATYPES: 1 ♀, same data (QM); 1 ♂, 2 ♀, Bellenden Ker Range, NEQ, Summit TV Stn., 1560m, 17 Oct-5 Nov 1981, EW/QM Pyr. (ANIC, CBM, QM); 1 ♂, Bellenden Ker Range, NEQ, Summit TV Stn., 1560m, 1-7 Nov 1981, EW/QM, QM Berlesate No. 346, 17°16'S, 145°51'E, RF, moss on trees & rocks (QM); 1 ♂, Bellenden Ker, NEQ, Centre Peak Summit, 10 Apr 1979, GM, QM Berlesate No. 10, 17°16'S, 145°51'E, RF, 1500m, moss on trees (CBM).

DIAGNOSIS

Medium-sized, quadrimaculate, with dark pronotum and transverse apical elytral elytral spot, distinguished from similarly patterned species by distinct microreticulation on the elytra, fully, but very weakly striate elytra, on lower surface bisinuate aedeagus with very wide apex, and 5-setose parameres.

DESCRIPTION

Measurements. Length: 2.25-2.45mm; width: 1.05-1.12mm. Ratios: Width pronotum/head: 1.64-1.68; width/length of pronotum: 1.46-1.49; width base/apex of pronotum: 1.63-1.67; width widest diameter/base of pronotum: 1.04-1.06; length/width of elytra: 1.32-1.35.

Colour. Reddish-piceous, head and that part of elytra between the spots and just behind apical spot slightly darker. Elytra at some distance behind shoulder with an inconspicuous, ill delimited, about triangular, light reddish spot attaining about position of 4th stria. In posterior 2/5 of elytra with a rather conspicuous, fairly well delimited, straight, oblique, light reddish spot or stripe, surrounded by dark colour, attaining about 3rd stria. Both spots usually well removed from lateral border. Legs light reddish, tibiae slightly darker.

Head. Median antennomeres c. 1.6 x as long as wide. Microreticulation distinct on most of head, weaker only on vertex, about isodiametric to slightly transverse. Surface somewhat dull.

Pronotum. Transverse, moderately convex, widest in or slightly behind of middle, base much wider than apex. Lateral margin posteriorly little curved, but feebly oblique, at posterior angles faintly incurved. Hence base but slightly narrower than widest part. Posterior angles fairly obtuse, distinctly produced over lateral part of base. Carina at posterior angle moderately elongate, rather oblique, slightly incurved. Anterior transverse sulcus fairly deep, not interrupted. Posterior transverse sulcus fairly deep, in middle shallower, but without conspicuous fovea. Anterior lateral seta situated well behind anterior third of margin. Microreticulation very distinct, almost isodiametric, surface rather dull.

Elytra. Rather short and convex, egg-shaped, widest slightly in front of middle. Lateral border evenly curved, extremely finely, almost not perceptibly, serrate and pilose. Sutural stria crenulate. 2nd stria in basal half slightly impressed. 3rd-5th striae near base very faintly impressed, outer striae very inconspicuous. All striae finely punctate, puncturation becoming even finer laterally and apically. Sutural interval convex throughout, 2nd interval slightly convex in basal half, outer intervals depressed. Only 1st and 2nd striae well visible at apex, outer striae barely perceptible. 8th stria deeply impressed throughout, punctate, attaining posterior marginal pore. Recurrent striae elongate, rather oblique, meeting position of 3rd stria. Anterior discal pore well behind anterior third, posterior pore well in front of posterior third. Microreticulation distinct, consisting of but feebly transverse meshes. Surface rather dull, Wings slightly shorter than elytra.

Lower surface. Metepisternum feebly longer than wide.

Male genitalia. Genital ring regularly triangular, wide, apex rather narrow. Aedeagus rather large, moderately compact, lower surface gently bisinuate, apex short and very wide, widely rounded off. Parameres large, elongate, both 5-setose.

Female genitalia. Stylomere 2 with stout dorsal ensiform seta situated rather medially.

Variation. Some variation noted in relative shape of pronotum and elytra and in degree of microreticulation.

DISTRIBUTION

Mt. Bellenden Ker, north Queensland. Known only from that mountain top.

HABITAT

Collected by pyrethrum knockdown on mossy trunks and rocks in montane rainforest above 1500m. Collected April, June, October, and November.

ETYMOLOGY

Refers to the remarkably dull surface.

***Philipis rufescens* sp. nov.**
(Figs 7A, 15A, 18D)

MATERIAL EXAMINED

HOLOTYPE: QMT13645; ♂, Bellenden Ker Range, NEQ, Summit TV Stn., 1560m, 17 Oct-5 Nov 1981, Earthwatch/Qld. Museum pyrethrum knockdown.

PARATYPES: 9 ♂, 7 ♀, same data (ANIC, CBM, QM, USNM, ZSM); 7 ♂, 1 ♀, Bellenden Ker, Centre Peak Summit, NEQ, 10 Apr 1979, GM, QM Berlesate No. 8, 17°16'S, 145°51'E, RF, 1500m, moss on trees (CBM, QM); 1 ♂, Bellenden Ker summit, NEQ, 10 June 1980, GM (QM); 19 ♂, 14 ♀, Bellenden-Ker Range, NEQ, Summit TV Stn., 1560m, 28 Oct 1983, GM, DY & GT, Pyr. in RF (ANIC, CBM, QM, USNM); 1 ♂, 4 ♀, Bellenden Ker Range, NEQ, Summit TV Stn., 1560m, 1-7 Nov 1981, EW/QM, QM Berlesate NO. 337, 340, 341, 343, 344, 17°16'S, 145°51'E, RF, sieved litter, stick brushings, stick & moss brushings, moss on trees & rocks (QM); 1 ♂, Mt. Bellenden Ker, Centre Peak Summit, NEQ, 10-12 Apr 1979, 1500m, GM (QM); 9 ♂, 4 ♀, 17°16'S, 145°52'E, Bellenden Ker summit, NEQ, 8 Oct 1991, 1560m, GM & HJ, Pyr., trees & logs (CBM, QM, ZSM).

DIAGNOSIS

Medium-sized, reddish-piceous, quadrimaculate, with red pronotum and oblique, slightly sinuate apical elytral spot, further distinguished by fully and deeply striate elytra, distinct microreticulation of elytra, evenly curved lower surface of aedeagus with short, convex apex, and 4-setose parameres.

DESCRIPTION

Measurements. Length: 2.15-2.45mm; width: 1.02-1.10mm. Ratios: Width pronotum/head: 1.56-1.63; width/length of pronotum: 1.36-1.45; width base/apex of pronotum: 1.38-1.41; width widest diameter/base of pronotum: 1.12-1.18; length/width of elytra: 1.37-1.38.

Colour. Head and dark parts of elytra reddish-piceous to piceous, pronotum, base and apex of elytra and suture more or less dark reddish. Elytra at shoulder with a medially rather ill delimited, about triangular, light reddish spot attaining about position of 4th stria. In posterior 2/5 of elytra with a rather conspicuous, fairly well delimited, oblique, though but slightly s-shaped, light reddish stripe, attaining about 2nd stria. Legs yellow to light reddish, barely infuscate.

Head. Median antennomeres c. 1.4 x as long as wide. Microreticulation distinct on most of head, weaker only on vertex, about isodiametric to slightly transverse. Surface somewhat dull.

Pronotum. Transverse, moderately convex, widest in front of middle, base much wider than

apex. Lateral margin posteriorly little curved, though rather oblique, at posterior angles perceptibly incurved. Posterior angles remarkably obtuse, distinctly produced over lateral part of base. Carina at posterior angle with elongate, little oblique, slightly incurved. Anterior transverse sulcus rather shallow, faintly interrupted in middle or at least becoming shallower. Posterior transverse sulcus fairly deep, interrupted by a rather large fovea. Anterior lateral seta situated well behind anterior third of margin. Microreticulation distinct, almost isodiametric, surfacesomewhatdull.

Elytra. Moderately short and convex, egg-shaped, widest slightly in front of middle. Lateral border evenly curved, extremely finely, almost not perceptibly, serrate and pilose. 1st and 2nd striae deeply impressed, crenulate. 3rd-5th striae in anterior half slightly impressed, outer striae faintly or barely impressed, though all striae easily visible as rows of rather fine punctures, that become finer laterally and apically. 1st and 2nd intervals convex throughout, 3rd-5th intervals near base more or less distinctly convex. Inner five striae just visible near apex. 8th stria deeply impressed throughout, punctate, attaining posterior marginal pore. Recurrent striae elongate, rather oblique, meeting 3rd stria. Anterior discal pore well behind anterior third, posterior pore in front of posterior third. Microreticulation distinct, though somewhat superficial, consisting of rather irregular, moderately transverse meshes. Surface moderately glossy. Wings markedly shortened.

Lower surface. Metepisternum about as long as wide.

Male genitalia. Genital ring regularly triangular, moderately wide, apex rather narrow. Aedeagus small, short and compact, lower surface concave, apex very short, widely rounded off. Parameres moderately elongate, both 4-setose.

Female genitalia. Stylomere 2 with stout dorsal ensiform seta situated rather medially.

Variation. Apart from some allometric variation of relative width and shape of pronotum, which in large specimens tends to be relatively wider, little variation noted.

DISTRIBUTION

Mt. Bellenden Ker, north Queensland. Known only from this mountain top.

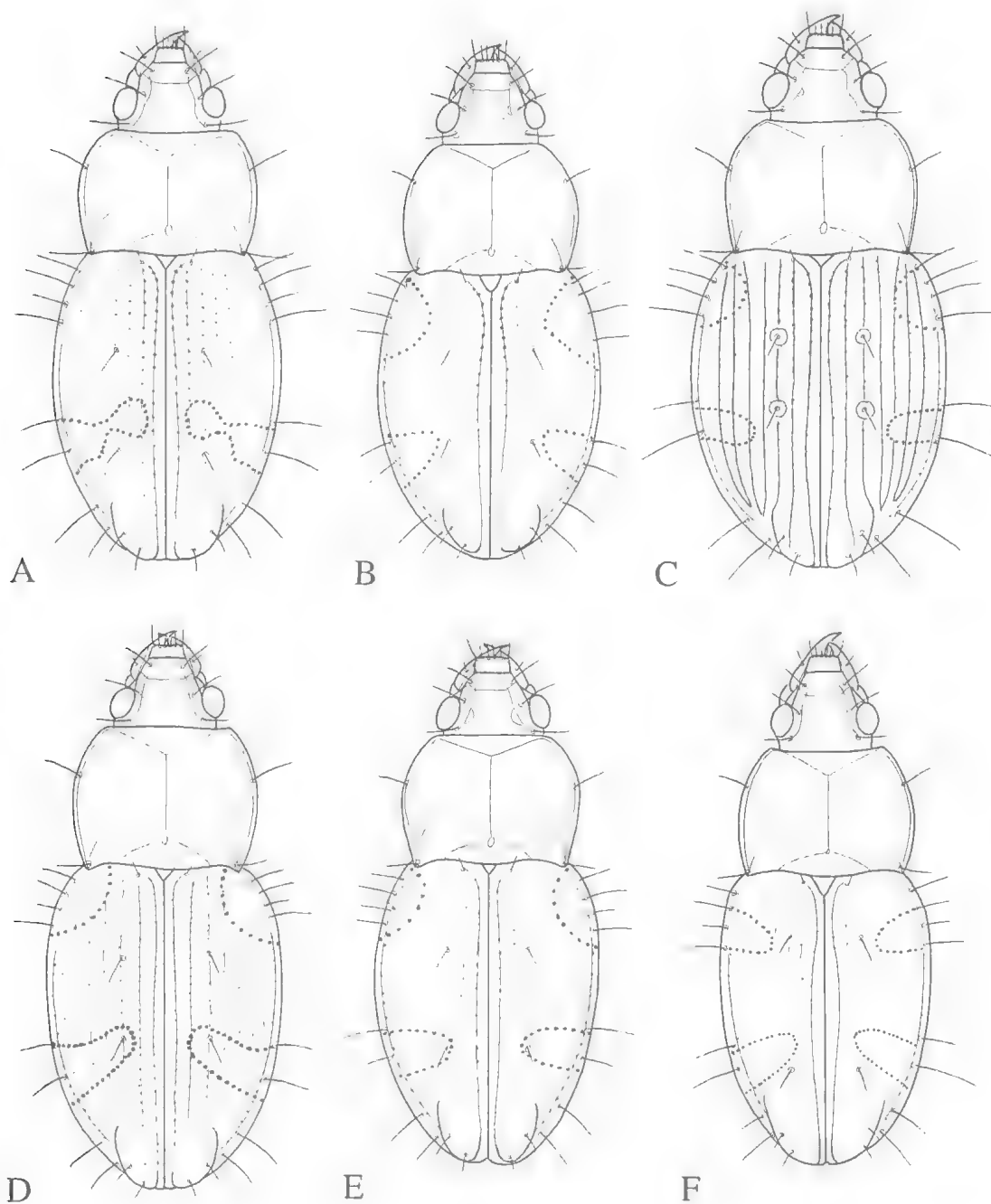


FIG. 14. Habitus. A, *P. vicina* sp. nov. B, *P. laevis* sp. nov. C, *Philipis sulcata* sp. nov. D, *P. frerei* sp. nov. E, *P. subtropica* sp. nov. F, *P. alutacea* sp. nov. Lengths: 2.2mm; 2.25mm; 2.4mm; 2.3mm; 2.75mm; 2.25mm.

HABITAT

Collected by pyrethrum knockdown on mossy trees and logs and by Berlese extraction of litter, moss, and sticks in montane rainforest above 1500m. Collected April, June, October, and November.

ETYMOLOGY

Refers to the generally reddish colour of this species.

***Philipis perstriata* sp. nov.**
(Figs 15B, 19A)

MATERIAL EXAMINED

HOLOTYPE: QMT 13726; ♀, Mt. Bartle Frere, NEQ, Sth. Peak Summit, 1620m, 6-8 Nov 1981, Earthwatch/Qld. Museum, pyrethrum knockdown.

DIAGNOSIS

Small, reddish-piceous, quadrimaculate, with reddish pronotum and oblique, slightly sinuate apical elytral spot, distinguished from *P. rufescens* sp. nov. by smaller size, narrower shape, sulcate elytral striae, and weak microreticulation of elytra.

DESCRIPTION

Measurements. Length: 2.05mm; width: 0.9mm. Ratios: Width pronotum/head: 1.64; width/length of pronotum: 1.41; width base/apex of pronotum: 1.37; width widest diameter/base of pronotum: 1.17; length/width of elytra: 1.39.

Colour. Reddish-piceous, pronotum, base, apex, suture, and lateral borders of elytra slightly lighter, reddish. Elytra behind shoulder with a large, though very inconspicuous, ill delimited, about triangular, light reddish spot attaining about 4th stria. In posterior 2/5 of elytra with an inconspicuous, very ill delimited, slightly oblique, narrow, light reddish fascia attaining about 2nd stria. Legs light reddish.

Head. Median antennomeres c. 1.2 x as long as wide. Microreticulation very distinct, coarse, only in posterior half somewhat superficial, about isodiametric to slightly transverse. Surface rather dull.

Pronotum. Transverse, moderately convex, widest slightly in front of middle, base much wider than apex. Lateral margin posteriorly almost straight, though rather oblique. Base distinctly narrower than widest part. Posterior angles almost rectangular, slightly obtuse, slightly produced over lateral part of base. Carina in posterior angle moderately elongate, little oblique, slightly incurved. Anterior transverse sulcus fairly shallow, slightly interrupted. Posterior transverse sulcus rather deep, interrupted by a large fovea. Anterior lateral seta situated well behind anterior third of margin. Microreticulation very distinct and coarse, slightly transverse, laterally even forming short, transverse wrinkles, surface markedly dull.

Elytra. Moderately short and convex, egg-shaped, widest about in middle. Lateral border evenly curved, not perceptibly serrate and pilose. Surface in posterior 2/5 just behind posterior fascia with large, transverse impression. All striae deeply impressed throughout, all intervals markedly convex. Punctuation of striae very fine, barely visible. 8th stria deeply impressed throughout, finely punctate, surpassing posterior marginal pore. Recurrent stria elongate, markedly oblique, anteriorly suddenly incurved, meeting 3rd stria. Anterior discal pore slightly behind anterior third, posterior pore well in front of posterior third. All marginal setae rather short. Microreticulation highly superficial, difficult to see, consisting of irregular, transverse meshes. Surface highly glossy. Wings markedly shortened. Variation unknown.

Lower surface. Metepisternum about as long as wide.

Genitalia. Male unknown. Female stylomere 2 with stout dorsal ensiform seta situated rather medially.

DISTRIBUTION

Mt. Bartle Frere, north Queensland. Known only from this mountain top.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks in montane rainforest above 1600m. Collected November.

ETYMOLOGY

Refers to the completely and deeply striate elytra.

***Philipis ellioti* sp. nov.**
(Figs 7B, 15C, 17B)

MATERIAL EXAMINED

HOLOTYPE: QMT13727; ♂, 19°30'S, 146°57'E, Mt. Elliot summit, NEQ, 1150m, 12 May 1991, D. Cook, pyrethrum, tree & logs.

PARATYPES: 6 ♂, 4 ♀, same data (ANIC, CBM, QM, USNM, ZSM); 1 ♂, 1 ♀, 19°29'S, 146°57'E, Mt. Elliot, NEQ, North Ck., 27 Mar 1991, 1000m, GM, Pyr., trees & logs (QM); 1 ♂, Mt. Elliot Summit, 30km SW

Townsville, NEQ, 13 Dec 1990, AG, Hand Collecting (QM).

DIAGNOSIS

Small, piceous, quadrimaculate, with ill delimited basal, and oblique, only slightly sinuate apical elytral spot, further distinguished by lack of microreticulation, rather elongate aedeagus with evenly curved lower surface, and commonly 4-setose right paramere.

DESCRIPTION

Measurements. Length: 2.0-2.15mm; width: 0.9-1.0mm. Ratios: Width pronotum/head: 1.50-1.53; width/length of pronotum: 1.38-1.46; width base/apex of pronotum: 1.28-1.43; width widest diameter/base of pronotum: 1.12-1.16; length/width of elytra: 1.35-1.41.

Colour. Head and dark parts of elytra piceous, pronotum, base, lateral border, and suture of elytra lighter, reddish. Behind shoulder with an inconspicuous, medially very ill delimited, circular, light reddish spot, attaining about 3rd stria, but difficult to tell from dark reddish base. In posterior 2/5 of elytra with a fairly conspicuous, rather well delimited, transverse, yellowish spot, attaining about 2nd stria. Legs dark yellow to light piceous.

Head. Median antennomeres barely longer than wide. Microreticulation distinct on labrum and anterior part of clypeus, superficial on frons, reduced on vertex, about isodiametric to slightly transverse. Surface moderately glossy.

Pronotum. Moderately transverse, fairly convex, widest about in middle or slightly in front of it, base much wider than apex. Lateral margin posteriorly but feebly convex or even straight, fairly oblique. Posterior angles rectangular, not produced over lateral part of base. Carina at posterior angle moderately elongate, fairly oblique, slightly incurved. Anterior transverse sulcus exceptionally shallow, not interrupted. Posterior transverse sulcus deep, interrupted by a rather large fovea. Anterior lateral seta situated behind anterior third of margin. Microreticulation very superficial or almost absent, surface glossy.

Elytra. Moderately short and convex, egg-shaped, widest slightly behind anterior third. Lateral border evenly curved, not perceptibly serrate and pilose. Sutural and 2nd striae deeply impressed, crenulate. 3rd-5th striae still visible as rows of rather coarse punctures at least in anterior half. Outer striae hardly perceptible. 1st and 2nd intervals convex, sometimes even 3rd interval slightly convex near base. Only 1st-3rd striae

traceable to apex. 8th stria deeply impressed, anteriorly slightly shallower, finely punctate, though anteriorly smooth, attaining posterior marginal pore. Recurrent striae elongate, moderately oblique, meeting 3rd stria. Anterior discal pore well behind anterior third, posterior pore slightly in front of posterior third. Microreticulation absent. Surface highly glossy. Wings shortened.

Lower surface. Metepisternum c. 1.2 x as long as wide.

Male genitalia. Genital ring triangular, feebly asymmetric, rather wide, apex narrow. Aedeagus rather small, moderately elongate, lower surface concave, apex short, fairly wide, widely rounded off. Parameres moderately elongate, right 5-setose, left 4- or 5-setose.

Female genitalia. Stylomere 2 with stout dorsal ensiform seta situated rather medially.

Variation. Little variation noted, apart from minor differences in shape of pronotum, shape of posterior elytral fascia, and number of setae on left male paramere.

DISTRIBUTION

Mt. Elliot south of Townsville, north Queensland. Known only from that mountain top.

HABITAT

Collected by pyrethrum knockdown on mossy trees and logs in montane rainforest above 1000m, only one specimen by "hand collecting". Collected March, May, and December.

ETYMOLOGY

Refers to the type locality, Mt. Elliot.

Philipis agnicapitis sp. nov.
(Figs 7C, 15D, 19A)

MATERIAL EXAMINED

HOLOTYPE: QMT13736; ♂, Lambs Head, 10km W Edmonton, NEQ, 10 Dec 1989, 1200m, Monteith, Thompson, Janetzki, pyrethrum, logs & trees.

PARATYPES: 1 ♂, 1 ♀, same data (CBM); 1 ♂, 2 ♀, Lambs Head, 10km W Edmonton, NEQ, 1200m, 11 Dec 1989 (2nd Tower), GM, GT, HJ, Pyr., logs & trees (QM, ZSM); 1 ♂, 1 (sex?), Lambs Head, 10km W Edmonton, NEQ, 4 Dec 1988, 1200m, GM & GT, Pyr./logs & trees (QM); 3 ♂, 2 ♀, 17°02'S, 145°40'E, Lambs Head, NEQ, (East End), 29 Nov 1993, 1180m, GM & HJ Pyr./trees & logs (ANIC, CBM, QM, USNM).

DIAGNOSIS

Small, reddish-piceous, quadrimaculate, with ill delimited basal, and only slightly oblique, barely sinuate apical elytral spot, further distinguished by lack of microreticulation, narrow pronotum, moderately elongate aedeagus with evenly curved lower surface, and 5-setose right paramere.

DESCRIPTION

Measurements. Length: 1.85–2.30mm; width: 0.85–1.05mm. Ratios: Width pronotum/head: 1.50–1.57; width/length of pronotum: 1.39–1.42; width base/apex of pronotum: 1.34–1.37; width widest diameter/base of pronotum: 1.13–1.15; length/width of elytra: 1.34–1.39.

Colour. Reddish-piceous to piceous, pronotum, apex and suture, sometimes also base of elytra faintly lighter. Elytra at shoulder with an inconspicuous, ill delimited, about triangular, light reddish spot attaining about position of 4th stria. In posterior 2/5 of elytra with a slightly more conspicuous, moderately well delimited, transverse, light reddish spot or stripe, attaining about 3rd or even 2nd stria. Legs yellowish to light reddish, tibiae sometimes faintly darker.

Head. Median antennomeres c. 1.2 x as long as wide. Microreticulation distinct, though fairly superficial on most of head, almost absent only on vertex, about isodiametric to slightly transverse. Surface moderately glossy.

Pronotum. Moderately transverse and convex, widest slightly in front of middle, base much wider than apex. Lateral margin posteriorly little or almost straight, though rather oblique. Base usually distinctly narrower than widest part. Posterior angles almost rectangular, barely obtuse, only feebly produced over lateral part of base. Carina at posterior angle moderately elongate, slightly oblique, slightly incurved. Anterior transverse sulcus fairly deep, feebly interrupted. Posterior transverse sulcus deep, interrupted by large fovea. Microreticulation very superficial, apparently slightly transverse, surface glossy.

Elytra. Rather short and convex, egg-shaped, widest slightly in front of middle. Lateral border evenly curved, extremely finely, almost not perceptibly, serrate and pilose. 1st and 2nd striae moderately impressed, rather finely punctate. 3rd–5th striae more or less distinctly impressed in basal half, outer striae very fine, barely perceptible. Puncturation generally rather fine. 1st and 2nd intervals gently convex throughout, outer intervals almost depressed, even in basal half. Only four inner striae visible at apex. 8th stria

deeply impressed throughout, distinctly punctate, attaining posterior marginal pore. Recurrent striae elongate, rather oblique, meeting 3rd stria. Anterior discal pore well behind anterior third, posterior pore in front of posterior third. Microreticulation extremely superficial, perceptible only laterally and near apex, consisting of irregular, transverse meshes. Surface glossy. Wings shortened.

Lower surface. Metepisternum about as long as wide.

Male genitalia. Genital ring almost regularly triangular, moderately wide, feebly asymmetric, apex rather narrow. Aedeagus rather short and compact, lower surface fairly concave, apex narrow, short, rounded off. Upper border sinuate near apex. Parameres rather short, both 5-setose.

Female genitalia. Stylomere 2 with stout dorsal ensiform seta situated rather medially.

Variation. Apart from minor differences in shape of pronotum and distinctness of elytral pattern, little variation noted.

DISTRIBUTION

Lambs Head west of Edmonton, north Queensland. Known only from that mountain top.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks and logs in montane rainforest at 1200m. Collected December only.

ETYMOLOGY

Refers to the type locality, Lambs Head.

Philipis picta sp. nov.
(Figs 7D, 15E, 19A)

MATERIAL EXAMINED

HOLOTYPE: QMT13744; ♂, Mt. Finnigan Summit via Helenvale, NEQ, 3–5 Dec 1990, 1050m, Monteith, Sheridan, Roberts & Thompson, pyrethrum.

PARATYPES: 3 ♀, same data (ANIC, CBM, QM); 2 ♀, Mt. Finnigan Summit, NEQ, 30 Nov 1985, GM & DC, QM Berlesate No. 685, 15°48'S, 145°17'E, RF, 1100m, moss on trees (CBM, QM); 1 ♀, Mt. Finnigan Summit, NEQ, 29 Nov 1985, GM & DC, QM Berlesate No. 699, 15°48'S, 145°17'E, RF, 1100m, moss on trees (QM).

DIAGNOSIS

Rather small to medium-sized, piceous, quadrimaculate, with light apex and base of elytra and oblique and sinuate apical elytral spot, further distinguished from *P. bicolor* sp. nov. by not contrastingly coloured pronotum, less contrast-

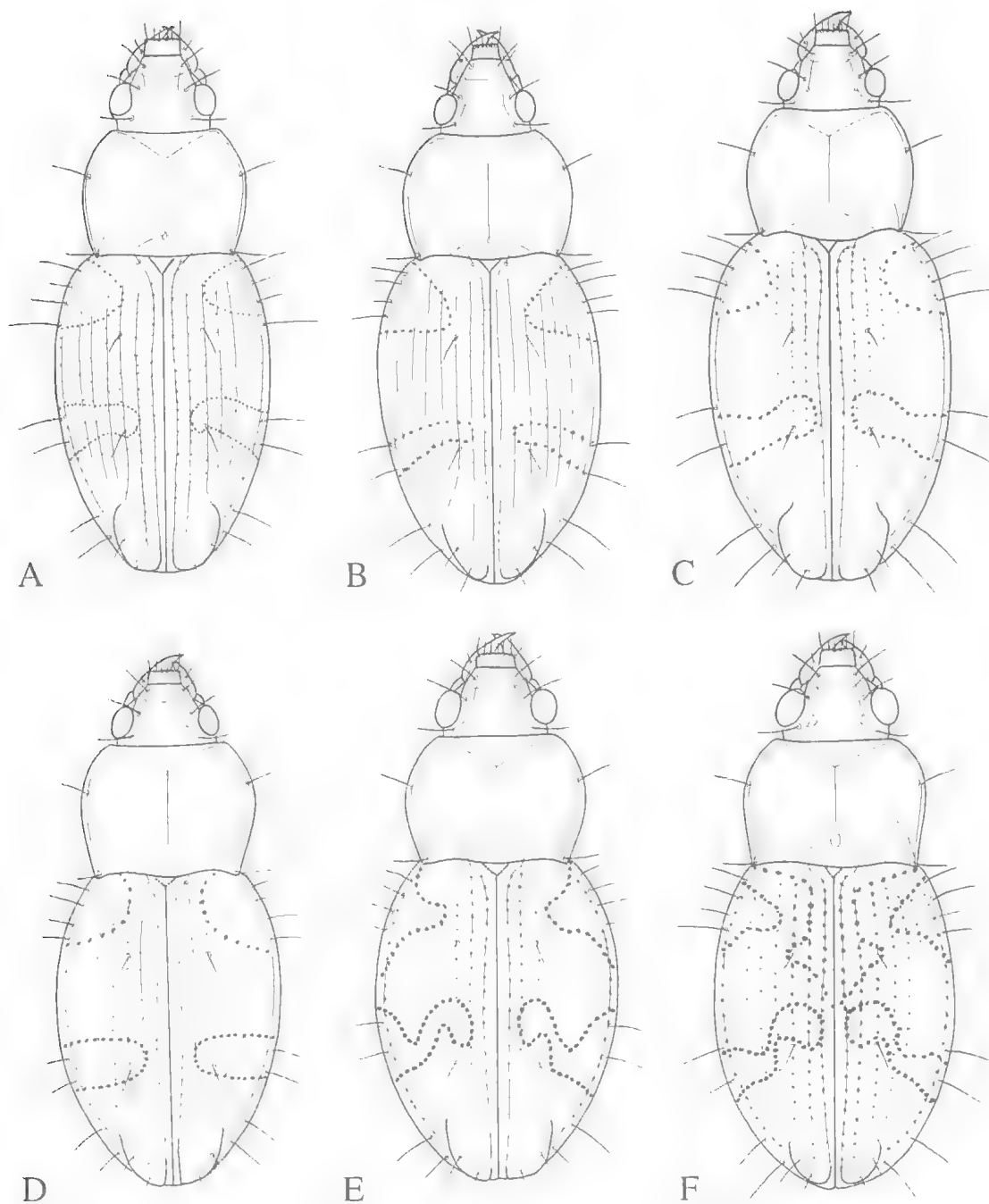


FIG. 15. Habitus. A, *Philipis rufescens* sp. nov. B, *P. perstriata* sp. nov. C, *P. ellioti* sp. nov. D, *P. agnicapitis* sp. nov. E, *Philipis picta* sp. nov. F, *P. bicolor* sp. nov. Lengths: 2.35mm; 2.05mm; 2.1mm; 2.25mm; 2.3mm; 2.3mm.

ing elytral pattern, less deeply striate and punctate base of elytra, and short, on lower surface evenly curved aedeagus with very short apex.

DESCRIPTION

Measurements. Length: 2.18-2.35mm; width: 1.02-1.04mm. Ratios: Width pronotum/head: 1.48-1.51; width/length of pronotum: 1.45-1.49; width base/apex of pronotum: 1.35-1.40; width widest diameter/base of pronotum: 1.12-1.16; length/width of elytra: 1.31-1.34.

Colour. Head and dark parts of elytra dark piceous, pronotum, base, and apex of elytra reddish-piceous. A fairly vague, triangular, laterally wide spot behind shoulder attaining medially about 4th stria, a rather well delimited, oblique, slightly s-shaped fascia in posterior 2/5 medially attaining about 2nd stria, and posterior half of suture yellow to light reddish. Legs yellow, tibiae and tarsi slightly darker.

Head. Median antennomeres c. 1.3 x as long as wide. Microreticulation distinct, though superficial, reduced on vertex, about isodiametric to slightly transverse. Surface moderately glossy.

Pronotum. Transverse, convex, widest about in middle or slightly in front of it, base much wider than apex. Lateral margin posteriorly slightly convex to almost straight, fairly oblique. Posterior angles not fully rectangular, slightly obtuse, feebly produced over lateral part of base. Carina at posterior angle elongate, markedly oblique, slightly incurved. Anterior transverse sulcus deep, not interrupted. Posterior transverse sulcus deep, interrupted by a rather large fovea. Anterior lateral seta situated well behind anterior third of margin. Microreticulation present only at apex and base, absent on disk, about isodiametric, surface glossy.

Elytra. Short, convex, egg-shaped, widest about in middle. Lateral border evenly curved, extremely finely serrate and pilose. Sutureal stria crenulate. 2nd-3rd striae, sometimes even 4th stria faintly impressed and coarsely, but very widely spaced punctate in basal half, outer striae very fine throughout, though usually just visible at high magnification. All, except of sutureal and 2nd stria disappearing behind middle. At least 1st-2nd intervals slightly convex in basal half, sutureal interval convex even to apex, 8th stria deeply impressed, anteriorly shallow, strongly punctate-crenulate, just attaining posterior marginal pore. Recurrent stria elongate, rather oblique, meeting position of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior third. Microreticula-

tion rather superficial, composed of irregular, moderately transverse meshes. Surface fairly glossy. Wings slightly shortened.

Lower surface. Metepisternum slightly longer than wide.

Male genitalia. Genital ring triangular, slightly asymmetric, moderately wide, apex rather narrow. Aedeagus short and compact, lower surface concave, apex very short and wide, widely rounded off. Parameres moderately elongate, both 5-setose.

Female genitalia. Stylomere 2 with stout dorsal ensiform seta situated rather medially.

Variation. Apart from some minor differences in relative shape of pronotum and in distinctness of elytral pattern, little variation noted.

DISTRIBUTION

Mt. Finnigan south of Cooktown, north Queensland. Known only from this mountain top.

HABITAT

Collected by pyrethrum knockdown and Berlese extraction of moss on trees in montane rainforest above 1050m. Collected November and December.

ETYMOLOGY

Refers to the striking elytral pattern.

***Philipis bicolor* sp. nov.**
(Figs 3, 7E, 15F, 19A)

MATERIAL EXAMINED

HOLOTYPE: QMT13748; ♂, Mt. Demi, 7km SW of Mossman, NEQ, 29 Oct 1983, 1100m, D. K. Yeates & G. I. Thompson, Pyrethrum knockdown in RF.
PARATYPES: 11 ♂, 13 ♀, same data (ANIC, CBM, QM, USNM, ZSM).

DIAGNOSIS

Rather small to medium sized, black, quadrimaculate, with light apex and base of elytra and oblique and sinuate apical elytral spot, further distinguished from *P. picta* sp. nov. by contrastingly red pronotum, markedly contrasting elytral pattern, more deeply striate and punctate base of elytra, and rather elongate, on lower surface faintly bisinuate aedeagus with fairly elongate apex.

DESCRIPTION

Measurements. Length: 2.0-2.45mm; width: 0.92-1.15mm. Ratios: Width pronotum/head: 1.50-1.55; width/length of pronotum: 1.53-1.61; width base/apex of pronotum: 1.44-1.49; width

widest diameter/base of pronotum: 1.07-1.09; length/width of elytra: 1.32-1.36.

Colour. Head and dark parts of elytra very dark piceous, almost black. Pronotum, shoulders, basal third of inner two or three intervals, apex, suture, and lateral border of elytra, reddish. A semicircular, laterally wide spot behind shoulder attaining medially about 4th stria, and a very oblique, s-shaped fascia in posterior 2/5 medially attaining about 2nd stria, yellow. Both spots conspicuous and well delimited. Legs yellow.

Head. Median antennomeres c. 1.3 x as long as wide. Microreticulation distinct only on labrum and anterior border of clypeus, on frons very superficial, absent on vertex, about isodiametric to slightly transverse. Surface highly glossy.

Pronotum. Transverse, convex, widest about in middle or slightly in front of it, base much wider than apex. Lateral margin posteriorly feebly convex or almost straight, or even faintly concave in front of posterior angles, fairly oblique. Posterior angles rectangular, feebly produced over lateral part of base. Carina at posterior angle very elongate, markedly oblique, slightly incurved. Anterior transverse sulcus deep, not interrupted. Posterior transverse sulcus deep, interrupted by a rather large fovea. Anterior lateral seta situated well behind anterior third of margin. Microreticulation absent on disk, superficial at apex and base, surface glossy.

Elytra. Short, convex, egg-shaped, widest about in middle. Lateral border evenly curved, extremely finely serrate and pilose. Sutural stria crenulate, 2nd-5th striae, sometimes even 6th stria faintly impressed and all striae in basal half coarsely, but very widely spaced punctate. Three to four inner striae visible near apex. At least 1st-4th intervals slightly convex in basal half, sutural interval convex throughout. 8th stria deeply impressed, anteriorly shallower, strongly punctate, anteriorly even crenulate, just attaining posterior marginal pore. Recurrent striae elongate, rather oblique, meeting 3rd stria. Anterior discal pore behind anterior third, posterior pore slightly in front of posterior third. Microreticulation absent. Surface highly glossy. Wings slightly shortened.

Lower surface. Metepisternum slightly longer than wide.

Male genitalia. Genital ring triangular, rather asymmetric, moderately wide, apex rather narrow. Aedeagus rather short and compact, lower surface gently bisinuate, apex fairly elongate, wide, widely rounded off. Parameres moderately elongate, both 5-setose.

Female genitalia. Stylomere 2 with stout dorsal ensiform seta situated rather medially.

Variation. Apart from some minor differences of size, relative shape of pronotum, and distinctness of pattern, little variation noted.

DISTRIBUTION

Mt. Demi south of Mossman, north Queensland. Known only from that mountain top.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks in montane rainforest at 1100m. Collected October only.

ETYMOLOGY

Refers to the strikingly bicoloured pattern.

***Philipis geoffreyi* sp. nov.**
(Figs 7B, 16A, 19B)

MATERIAL EXAMINED

HOLOTYPE: QMT13767; ♂, 16°22'S, 145°13'E, 7km N. Mt. Spurgeon (Camp 2), NEQ, 17-19 Oct 1991, 1250m, Monteith & Janetzki, Pyrethrum, trees & logs. **PARATYPE:** 1 ♀, 16°24'S, 145°13'E, Stewart Ck., 4km NNE Mt. Spurgeon (Camp 1), NEQ, 1250-1300m, 15 Oct 1991, Pyr., GM & IU (CBM).

DIAGNOSIS

Rather small, dark piceous, quadrimaculate, with distinct, triangular subbasal, and oblique and sinuate apical elytral spots, further distinguished from *P. minor* sp. nov. by larger size, wider pronotum, and shorter elytra.

DESCRIPTION

Measurements. Length: 2.12-2.16mm; width: 1.02-1.04mm. Ratios: Width pronotum/head: 1.51-1.55; width/length of pronotum: 1.55-1.57; width base/apex of pronotum: 1.42-1.46; width widest diameter/base of pronotum: 1.08-1.09; length/width of elytra: 1.29-1.31.

Colour. Dark piceous, pronotum and posterior half of suture of elytra, sometimes also base of elytra reddish-piceous. Pronotum distinctly lighter than head and elytra. Lateral border of elytra, a triangular, laterally wide spot behind shoulder attaining medially about 4th stria, and a conspicuous, very oblique, s-shaped fascia in posterior 2/5 medially attaining about 2nd stria, yellow. Both spots conspicuous and well delimited. Legs yellow.

Head. Median antennomeres c. 1.3 x as long as wide. Microreticulation distinct, though superfi-

cial, reduced on vertex, about isodiametric to slightly transverse. Surface moderately glossy.

Pronotum. Transverse, convex, widest about in middle, base much wider than apex. Lateral margin posteriorly slightly convex to almost straight, fairly oblique. Posterior angles rectangular, feebly produced over lateral part of base. Carina at posterior angle elongate, markedly oblique, slightly incurved. Anterior transverse sulcus deep, not interrupted. Posterior transverse sulcus very deep, interrupted by a large fovea. Anterior lateral seta situated well behind anterior third of margin. Microreticulation very superficial, slightly transverse, surface rather glossy.

Elytra. Short, highly convex, egg-shaped, widest about in middle. Lateral border evenly curved, extremely finely serrate and pilose. Sutural stria crenulate. 2nd-5th striae slightly impressed and coarsely punctate at least in basal half, outer striae very fine even in anterior half. All, except of sutural and 2nd stria disappearing behind middle. At least 1st-3rd intervals slightly convex in basal half, sutural interval convex throughout. 8th stria deeply impressed, anteriorly shallow, strongly punctate-crenulate, just attaining posterior marginal pore. Recurrent striae elongate, rather oblique, meeting position of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior third. Microreticulation distinct, though somewhat superficial, composed of rather irregular, moderately transverse meshes. Surface moderately glossy. Wings slightly shortened.

Lower surface. Metepisternum slightly longer than wide.

Male genitalia. Genital ring asymmetrically triangular, fairly narrow, apex rather wide. Aedeagus moderately short and compact, lower surface almost imperceptibly bisinuate, apex short, rounded off. Parameres rather elongate, both 5-setose.

Female genitalia. Stylomere 2 with stout dorsal ensiform seta situated rather medially.

Variation. Apart from some minor differences in depth of ground colour, little variation noted.

DISTRIBUTION

To the north of Mt. Spurgeon, western part of Carbine Tableland, north Queensland.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks in montane rainforest above 1250m. Collected October.

ETYMOLOGY

Named in honour of the collector of most specimens of the genus *Philipis*, Dr. Geoffrey Monteith of the Queensland Museum.

Philipis minor sp. nov.

(Figs 8A, 16B, 19B)

MATERIAL EXAMINED

HOLOTYPE: QMT13768; ♂, Mossman Bluff Track, 10km W Mossman, NEQ, 21 Dec 1989, 1180m, Monteith & Thompson, pyrethrum (Site 8).

DIAGNOSIS

Small, dark piceous, quadrimaculate, with distinct, triangular subbasal and oblique and sinuate apical elytral spot, further distinguished from *P. geoffreyi* sp. nov. by lesser size, narrower pronotum, and longer elytra.

DESCRIPTION

Measurements. Length: 2.0mm; width: 0.96mm. Ratios: Width pronotum/head: 1.45; width/length of pronotum: 1.47; width base/apex of pronotum: 1.34; width widest diameter/base of pronotum: 1.11; length/width of elytra: 1.35.

Colour. Dark piceous, posterior half of suture and apex of elytra reddish-piceous. Pronotum not lighter than head and elytra. Lateral border of elytra, a triangular, laterally wide spot behind shoulder attaining medially about 4th stria, and a conspicuous, very oblique, s-shaped fascia in posterior 2/5 medially attaining about 2nd stria, yellow. Both spots conspicuous and well delimited. Legs yellow.

Head. Median antennomeres c. 1.3 x as long as wide. Microreticulation superficial, reduced on vertex, about isodiametric to slightly transverse. Surface moderately glossy.

Pronotum. Fairly transverse, convex, widest well in front of middle, base much wider than apex. Lateral margin posteriorly straight, fairly oblique. Posterior angles rectangular, feebly produced over lateral part of base. Carina at posterior angle elongate, markedly oblique, slightly incurved. Anterior transverse sulcus deep, not interrupted. Posterior transverse sulcus very deep, interrupted by a large fovea. Anterior lateral seta situated well behind anterior third of margin. Microreticulation very superficial, slightly transverse, surface rather glossy.

Elytra. Rather short, highly convex, egg-shaped, widest about in middle. Lateral border evenly curved, extremely finely serrate and pilose. Sutural stria crenulate. 2nd-5th striae fairly impressed and coarsely punctate at least in basal

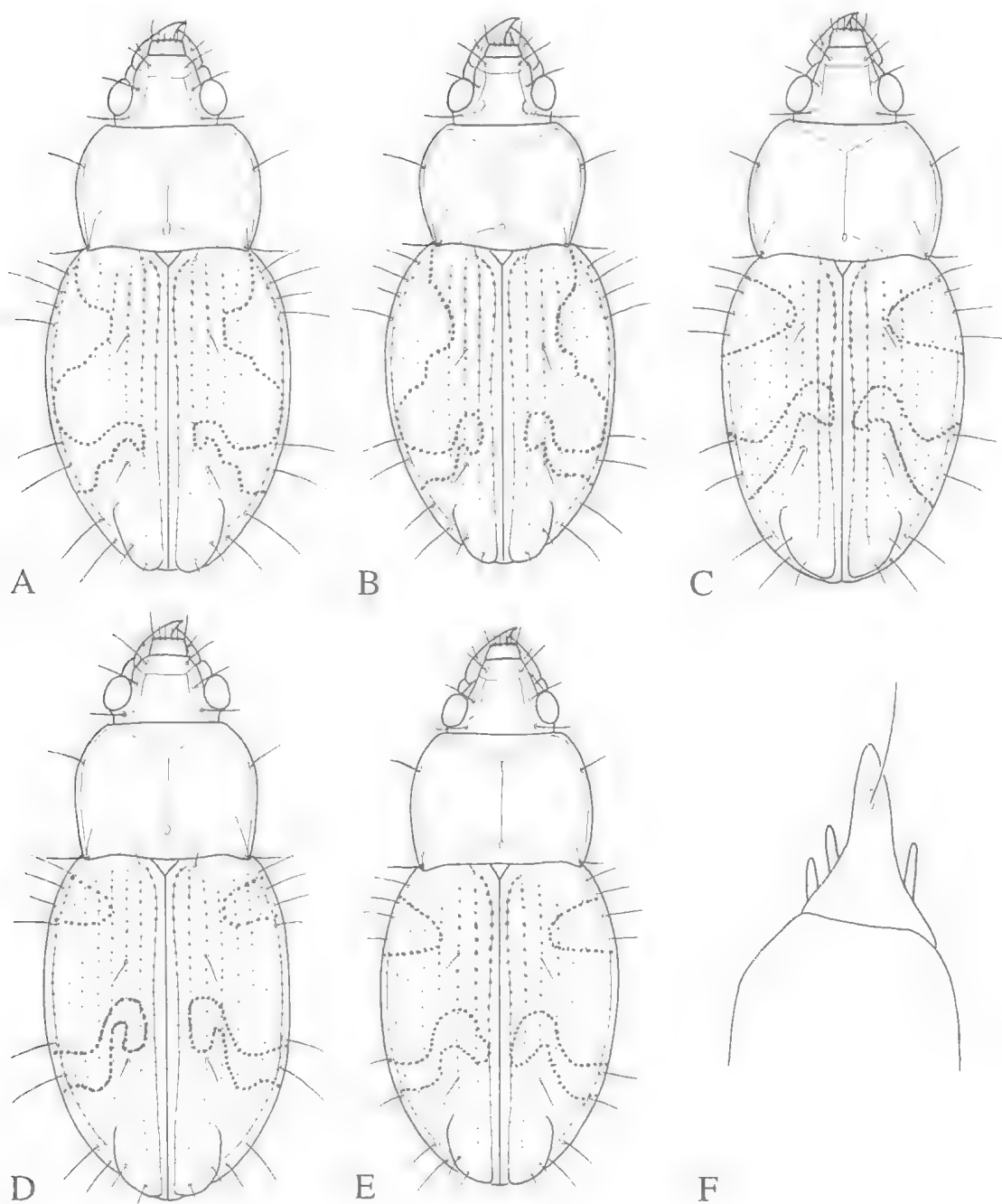


FIG. 16. Habitus. A, *P. geoffreyi* sp. nov. B, *P. minor* sp. nov. C, *Philipis sinuata* sp. nov. D, *P. distinguenda* sp. nov. E, *P. lustrans* sp. nov. F, *P. quadraticollis* sp. nov. ♀ styli. Lengths: 2.65mm; 2.6mm; 2.4mm; 2.15mm; 2.0mm.

half, outer striae very fine even in anterior half. All, except of sutural and 2nd stria disappearing behind middle. At least 1st-4rd intervals slightly convex in basal half, sutural interval convex throughout. 8th stria deeply impressed throughout, strongly punctate-crenulate, attaining posterior marginal pore. Recurrent striole elongate, rather oblique, meeting position of 3rd stria. Anterior discal pore in anterior third, posterior pore slightly in front of posterior third. Microreticulation distinct, though somewhat superficial, composed of rather irregular, moderately transverse meshes. Surface moderately glossy. Wings slightly shortened. Variation unknown.

Lower surface. Metepisternum slightly longer than wide.

Genitalia. Male genital ring asymmetrically triangular, moderately wide, apex rather narrow. Aedeagus rather short and compact, lower surface distinctly bisinuate, apex short, wide, widely rounded off. Parameres moderately elongate, both 5-setose, most posterior seta on lower surface rather removed from penultimate. On upper side behind last seta with an additional puncture, but without seta. Female genitalia unknown.

DISTRIBUTION

Mountains west of Mossman, north Queensland. Known only from type locality.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks in montane rainforest at 1180m. Collected December only.

ETYMOLOGY

Refers to the smaller size compared with the closely related species *P. geoffreyi*.

Philipis sinuata sp. nov.
(Figs 8B, 16C, 19B)

MATERIAL EXAMINED

HOLOTYPE: QMT13769; ♂, Mt. Bartle-Frere, NEQ, summit creek, 24 Sept 1981, G. Monteith & D. Cook, QM Berlesate No. 304, rainforest, 1500m, sieved litter.
PARATYPES: 7 ♂, 2 ♀, same data (CBM, QM); 2 ♂, Mt. Bartle Frere, NEQ, Sth. Peak Summit, 1620m, 6-8 Nov 1981, EW/QM Pyr. (CBM, QM); 1 ♂, Mt. Bartle Frere, NEQ, Campsite, 1500m, 27 Dec 1989, GM, Pyr., trees & rocks (QM); 1 ♀, Mt. Bartle Frere, NEQ, NW-Centre Peak, 16 Sept 1982, 1500m, GM & SM (QM); 2 ♂, 4 ♀, Bellenden Ker, Centre Peak Summit, NEQ, 10 Apr 1979, GM, QM Berlesate No. 8, 17°16'S, 145°51'E, RF, 1500m, moss on trees (QM, ZSM); 1 ♀, Bellenden Ker Summit, NEQ, 10 June 1980, GM, QM Berlesate No. 221, 17°16'S, 145°52'E, RF, 1561m,

moss on trees (QM); 7 ♂, 4 ♀, Bellenden Ker Range, NEQ, Summit TV Stn., 1560m, 17 Oct-5 Nov 1981, EW/QM Pyr. (ANIC, CBM, QM, USNM, ZSM); 2 ♂, Bellenden Ker Range, NEQ, Summit TV Stn., 1560m, 25-31 Oct 1981, EW/QM, QM Berlesate No. 373, 17°16'S, 145°51'E, RF, moss on trees (QM); 2 ♂, 1 ♀, Bellenden Ker Range, NEQ, Summit TV Stn., 1560m, 1-7 Nov 1981, EW/QM, QM Berlesate No. 346, 17°16'S, 145°51'E, RF, moss on trees & rocks (CBM, QM); 1 ♂, Bellenden Ker Range, NEQ, Summit TV Stn., 29 Apr-2 May 1983, GM, DY, QM Berlesate No. 562, 17°16'S, 145°51'E, RF, 1560m, moss (QM); 32 ♂, 16 ♀, Bellenden-Ker Range, NEQ, Summit TV Stn., 1550m, 28 Oct 1983, GM, DY & GT, Pyr. in RF (CBM, QM); 1 ♂, 2 ♀, 17°16'S, 145°52'E, Bellenden Ker summit, NEQ, 8 Oct 1991, 1560m, GM & HJ, Pyr., trees & logs (QM).

DIAGNOSIS

Large, dark piceous, quadrimaculate, with oblique, markedly sinuate apical elytral spot, further distinguished by distinct microreticulation on frons and elytra, wide pronotum with remarkably wide base, short aedeagus with faintly curved lower surface, and 5-setose right paramere.

DESCRIPTION

Measurements. Length: 2.6-2.75mm; width: 1.2-1.3mm. Ratios: Width pronotum/head: 1.65-1.73; width/length of pronotum: 1.51-1.56; width base/apex of pronotum: 1.51-1.59; width widest diameter/base of pronotum: 1.09-1.11; length/width of elytra: 1.34-1.36.

Colour. Dark piceous, pronotum, base of elytra and suture slightly lighter. Elytra at shoulder with a rather ill delimited, triangular, light reddish spot attaining about position of 4th stria. In posterior 2/5 of elytra with a conspicuous, well delimited, markedly s-shaped, yellowish stripe attaining about sutural stria. Medio-anteriorly this stripe is markedly bent and encircles the posterior elytral pore. Both elytral pores situated within a small, light spot. Legs yellow, barely infuscate.

Head. Median antennomeres c. 1.8 x as long as wide. Microreticulation very distinct on labrum and anterior part of clypeus, distinct, though fairly superficial on frons and vertex, about isodiametric to slightly transverse. Surface fairly glossy.

Pronotum. Transverse, rather convex, widest behind middle, base much wider than apex. Lateral margin posteriorly little curved, though rather oblique, at posterior angles perceptibly incurved. Posterior angles rectangular, though somewhat obtuse, distinctly produced over lateral part of base. Carina at posterior angle elon-

gate, markedly oblique, slightly incurved. Anterior transverse sulcus rather deep, not interrupted. Posterior transverse sulcus deep, interrupted by a large fovea. Anterior lateral seta situated well behind anterior third of margin. Microreticulation distinct, though superficial, almost isodiametric, surface rather glossy.

Elytra. Moderately short and convex, egg-shaped, widest at or slightly in front of middle. Lateral border evenly curved, extremely finely, almost not perceptibly, serrate and pilose. Sutural stria crenulate. 2nd stria distinctly impressed in basal half, 3rd-5th striae at base still faintly impressed, outer striae not impressed, though all striae easily visible as rows of rather coarse punctures that laterally and apically become finer. 1st interval convex throughout, 2nd-4th intervals near base more or less distinctly convex. Inner four striae just visible near apex. 8th stria deeply impressed throughout, strongly punctate, attaining posterior marginal pore. Recurrent striae elongate, rather oblique, meeting 3rd stria. Anterior discal pore well behind anterior third, posterior pore in front of posterior third. Microreticulation distinct, though superficial, consisting of rather irregular, transverse meshes. Surface moderately glossy. Wings shortened, though still surpassing elytra.

Lower surface. Metepisternum about as long as wide.

Male genitalia. Genital ring asymmetrically triangular, narrow, apex rather wide. Aedeagus rather large, though short and compact, lower surface feebly concave, apex very short, widely rounded off. Parameres moderately elongate, both 5-setose.

Female genitalia. Stylomere 2 with stout dorsal ensiform seta situated rather medially.

Variation. A rather homogenous species. There is, however, apparently some allometric variation, since large specimens tend to have relatively wider pronotum with wider base.

DISTRIBUTION

Bellenden Ker Range, north Queensland.

HABITAT

Collected by pyrethrum knockdown on mossy trees and by Berlese extraction of moss and litter in montane rainforest above 1500m. Species occurs only on the very summits of the range.

ETYMOLOGY

Refers to the sinuate, markedly s-shaped posterior elytral fascia.

Philipis distinguenda sp. nov. (Figs 8C, 16D, 19B)

MATERIAL EXAMINED

HOLOTYPE: QMT13833; ♂, Mossman Bluff Track 10km W Mossman, NEQ, 17 Dec 1988, 1200m, Monteith & Thompson, pyrethrum/trees & logs.

PARATYPE: 1 ♂, Mossman Bluff Track 6km W Mossman, NEQ, 16 Dec 1988, 480m, GM & GT, Pyrethrum/trees & logs (CBM).

DIAGNOSIS

Large, dark piceous, quadrimaculate, with oblique, markedly sinuate apical elytral spot, further distinguished from closely related *P. sinuata* sp. nov. by narrower pronotum with narrower base, longer elytra, and slightly longer aedeagus with gently bisinuate lower surface and slightly longer apex.

DESCRIPTION

Measurements. Length: 2.6-2.65mm; width: 1.18-1.24mm. Ratios: Width pronotum/head: 1.59-1.60; width/length of pronotum: 1.45-1.47; width base/apex of pronotum: 1.45-1.47; width widest diameter/base of pronotum: 1.10-1.12; length/width of elytra: 1.38-1.41.

Colour. Head and dark parts of elytra rather dark piceous, pronotum, basal third, apex, lateral borders, and suture of elytra slightly lighter, reddish-piceous. Elytra at shoulder with a very ill delimited, triangular, yellowish spot attaining about position of 4th stria. In posterior 2/5 of elytra with a conspicuous, well delimited, markedly s-shaped, yellowish stripe medially attaining about 2nd stria. Medio-anteriorly this stripe is sharply bent and touches the posterior elytral pore. Legs yellow, tibiae faintly darker.

Head. Median antennomeres c. 1.8 x as long as wide. Microreticulation distinct on labrum and anterior part of clypeus, fairly superficial on frons and vertex, about isodiametric to slightly transverse. Surface fairly glossy.

Pronotum. Transverse, rather convex, widest about in middle, base much wider than apex. Lateral margin posteriorly little curved, though rather oblique, at posterior angles perceptibly incurved. Posterior angles rectangular, though at tip slightly obtuse, distinctly produced over lateral part of base. Carina at posterior angle elongate, markedly oblique, slightly incurved. Anterior transverse sulcus rather deep, not interrupted. Posterior transverse sulcus deep, interrupted by a large fovea. Anterior lateral seta situated well behind anterior third of margin.

Microreticulation distinct, though superficial, almost isodiametric, surface rather glossy.

Elytra. Moderately short and convex, egg-shaped, widest at or slightly in front of middle. Lateral border evenly curved, extremely finely, almost not perceptibly, serrate and pilose. 1st and 2nd striae deeply impressed, crenulate. All other striae also more or less impressed in basal half. Striae rather coarsely punctate-crenulate, though puncturation laterally and apically finer. 1st and 2nd intervals convex throughout, 3rd-5th intervals in basal half rather distinctly convex, outer intervals just feebly convex. Inner four striae visible near apex. 8th stria deeply impressed throughout, strongly punctate, attaining posterior marginal pore. Recurrent striae elongate, rather oblique, meeting 3rd stria. Anterior discal pore well behind anterior third, posterior pore in front of posterior third. Microreticulation distinct, though superficial, consisting of slightly irregular, transverse meshes. Surface moderately glossy. Wings slightly shortened, though still surpassing elytra.

Lower surface. Metepisternum c. 1.2 x as long as wide.

Genitalia. Male genital ring triangular, narrow, slightly asymmetric, apex rather wide. Aedeagus short and compact, lower surface feebly bisinuate, apex very short, widely rounded off. Parameres, especially right paramere, short and wide, both 5-setose. Female genitalia unknown.

Variation. Due to few available specimens little variation noted.

DISTRIBUTION

Track to Mossman Bluff west of Mossman, north Queensland. Known from only two localities on this track.

HABITAT

Collected by pyrethrum knockdown on mossy trees and logs in rainforest at 480m and 1200m height. Collected December only.

ETYMOLOGY

Refers to the close external similarity with *P. sinuata*.

***Philipis lustrans* sp. nov.**
(Figs 8D, 16E, 19B)

MATERIAL EXAMINED

HOLOTYPE: QMT13834; ♂, North Bell Peak, NEQ, Malbon Thompson Ra., 20 Nov 1990, 1000m, Monleith & Thompson, pyrethrum-trees & logs.

PARATYPES: 6 ♂, 3 ♀, same data (ANIC, CBM, QM, USNM, ZSM); 3 ♂, 3 ♀, Bellenden Ker Range, NEQ, Cable Tower 3, 1054m, 17 Oct-5 Nov 1981, EW/QM Pyr. (CBM, QM); 1 ♂, 17°16'S, 145°50'E, Massey/Bellenden Ker saddle, NEQ, 9 Oct 1991, 950m, GM, HJ & DC, Pyr., trees & logs (QM); 1 ♂, 1 ♀, 17°14'S, 145°48'E, Massey Ra., NEQ, 6 km NW of Bellenden Ker, 1150m, 11 Oct 1991, Pyr., GM & HJ (QM); 1 ♂, Mt Bartle Frere, NEQ, West Side, 1050m, 8 Dec 1990, GM, GT & RS, Pyr.-trees & rocks (QM); 4 ♂, Lambs Head, 10km W Edmonton, NEQ, 10 Dec 1989, 1200m, GM, GT & HJ, Pyr., logs & trees (QM); 4 ♂, 1 ♀, Lambs Head, 10km W Edmonton, NEQ, 1200m, 11 Dec 1989, (2nd Tower) GM, GT & HJ, Pyr., logs & trees (CBM, QM).

DIAGNOSIS

Medium-sized, dark piceous, quadrimaculate, with oblique, markedly sinuate apical elytral spot, further distinguished from related species by narrower base of the wide pronotum, absence of microreticulation on frons and elytra, and short aedeagus with gently bisinuate lower surface.

DESCRIPTION

Measurements. Length: 2.2-2.5mm; width: 1.0-1.16mm. Ratios: Width pronotum/head: 1.56-1.62; width/length of pronotum: 1.51-1.57; width base/apex of pronotum: 1.46-1.51; width widest diameter/base of pronotum: 1.09-1.13; length/width of elytra: 1.33-1.37.

Colour. Fairly dark piceous, suture, sometimes also base and apex of elytra and even pronotum faintly lighter. Elytra behind shoulder with a moderately conspicuous, medially fairly ill delimited, about triangular, light reddish spot attaining about position of 4th stria. In posterior 2/5 of elytra with a conspicuous, well delimited, oblique, markedly s-shaped, yellowish or light reddish fascia attaining sutural stria. The sharply bent median part of the fascia situated well in front of posterior discal seta. Legs yellowish to light reddish.

Head. Median antennomeres c. 1.75 x as long as wide. Microreticulation very indistinct, highly superficial on most of head, absent on vertex, about isodiametric to slightly transverse. Surface highly glossy.

Pronotum. Rather transverse and convex, widest about in middle, base much wider than apex. Lateral margin posteriorly little curved, rather oblique. Base distinctly narrower than widest part. Posterior angles almost rectangular, slightly obtuse, faintly produced over lateral part of base. Carina at posterior angle elongate, rather oblique, slightly incurved. Anterior transverse sulcus deep, not interrupted. Posterior transverse sulcus

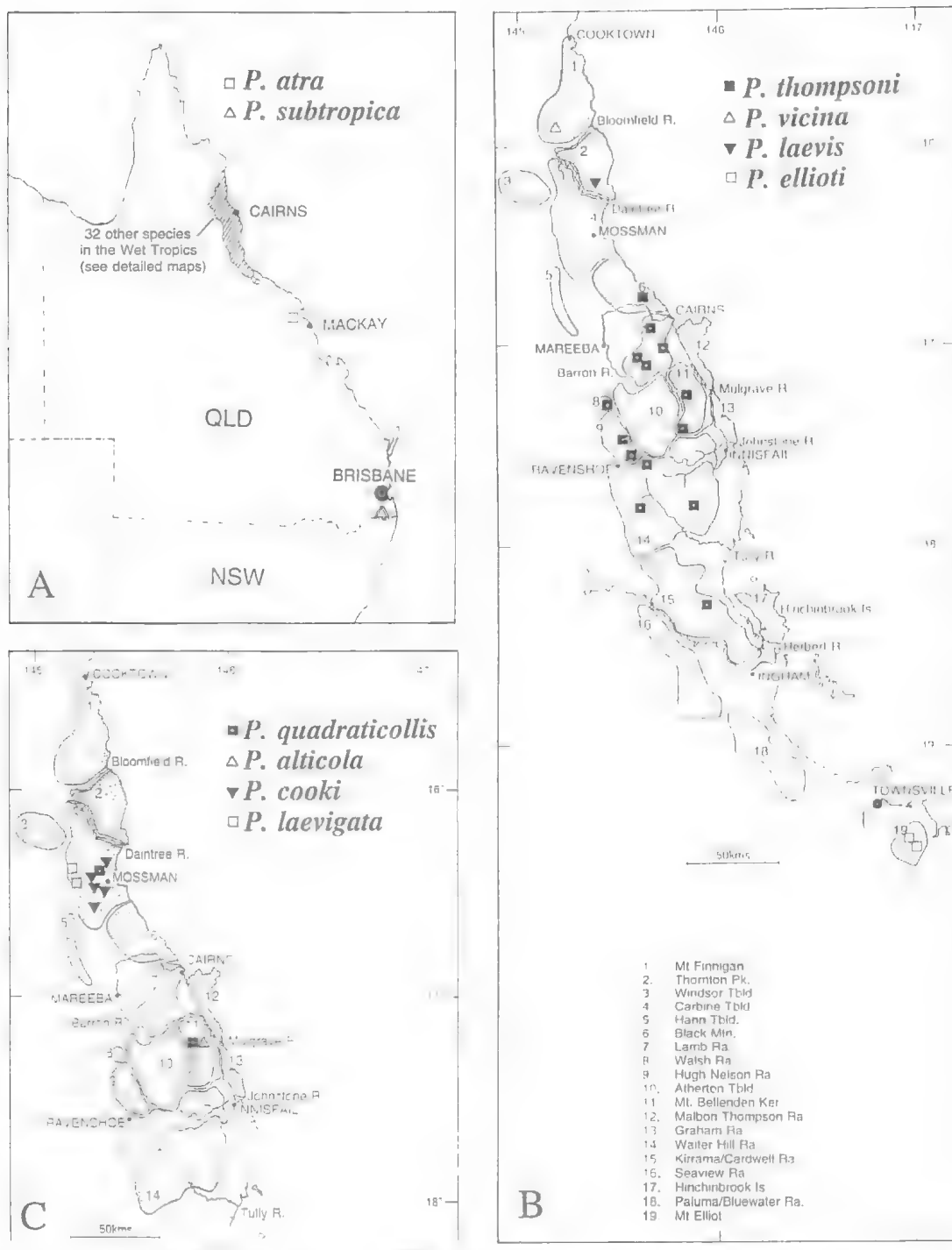


FIG. 17. Distribution of *Philipis* species. A, Queensland showing *P. atra* sp. nov. and *P. subtropica* sp. nov., plus combined extent of 33 tropical species. B, Wet tropics region showing *P. thompsoni* sp. nov., *P. vicina* sp. nov., *P. laevis* sp. nov., *P. ellioti* sp. nov. and the 19 rainforest survey zones used in the collection program. C, *P. quadraticollis* sp. nov., *P. alticola* sp. nov., *P. cooki* sp. nov. and *P. laevigata* sp. nov.

deep, interrupted by large fovea. Anterior lateral seta situated well behind anterior third of margin. Microreticulation very superficial to barely perceptible, apparently slightly transverse, surface highly glossy.

Elytra. Moderately short and convex, egg-shaped, widest slightly in front of middle. Lateral border evenly curved, extremely finely serrate and pilose. 1st and 2nd striae moderately impressed throughout. 3rd-5th striae more or less distinctly impressed in basal half, even outer striae sometimes faintly impressed, and all striae rather coarsely punctate. 1st and 2nd intervals gently convex throughout, 3rd-5th intervals gently convex in basal half, sometimes even outer intervals slightly convex, though apically depressed. Only four to five inner striae visible at apex. 8th stria deeply impressed throughout, distinctly punctate, attaining posterior marginal pore. Recurrent striae elongate, rather oblique, meeting 3rd stria. Anterior discal pore about in anterior third, posterior pore about in posterior third. Microreticulation extremely superficial, just perceptible only laterally and near apex, consisting of irregular, transverse meshes. Surface highly glossy. Wings slightly shortened, though yet longer than elytra.

Lower surface. Metepisternum c. 1.2 x as long as wide.

Male genitalia. Genital ring almost regularly triangular, moderately wide, feebly asymmetric, apex rather narrow. Aedeagus very short and compact, lower surface basally faintly bisinuate, in apical third curved down, apex rather narrow, short, rounded off. Apical part of aedeagus conspicuously covered with large microtrichia. Parameres rather short, both 5-setose.

Female genitalia. Stylomere 2 with stout dorsal ensiform seta situated rather medially.

Variation. Apart from minor differences in shape of pronotum and degree of microreticulation on pronotum and elytra, little variation noted.

DISTRIBUTION

Mountains at and near the eastern border of Atherton Tableland in the Lamb, Bellenden Ker, and Malbon Thompson Ranges, north Queensland.

HABITAT

Collected by pyrethrum knockdown on mossy tree trunks, logs, and rocks in montane rainforest between 950-1200m. Collected October to December.

ETYMOLOGY

Refers to the glossy surface as compared with related species.

NATURAL HISTORY

Available data indicate that all species of *Philipis* are arboreal and inhabit rainforest living on mossy tree trunks. Most specimens were captured by pyrethrum spraying of the moss on the trunks of rainforest trees. Even those specimens that have been collected by Berlese extraction were sampled from moss litter from vertical surfaces. Almost no specimens have been collected by hand sampling which is perhaps due to their small size and their habits under the cover of the moss. Only one specimen has been so far found under bark. This could be due to failure of appropriate sampling, but more likely it reflects their absence from that habitat.

Despite the time, energy and inspiration devoted by G. Monteith and his colleagues, the number of available specimens remains small, excepting a few more common species. Difficulties in obtaining such specimens may be illustrated by the fact that P. J. Darlington, certainly a skilful collector in the rainforests of Australia, recovered only a single specimen of this genus during his long stay in the area (actually his son collected the specimen). Occurrence of almost all species high on mountain tops, some of which are rather remote, makes their collection difficult. In general, collecting work means a strenuous ascent often through dense montane rainforest to mountain tops, and careful sampling was hindered by wet weather. Perhaps these beetles are actually more common than we know, and additional appropriate sampling work may bring to light even more species and much more material.

Most collecting took place from October to December just before onset of the wet season. Thus the actual main activity period of these beetles is unclear. According to G. Monteith (pers. comm.) they are less common during the dry season, hence I think that the activity period of these beetles is the wet season and the few months before, when storms begin to bring some rain. No specimens have been so far recorded at light, although several species are fully winged and may be able to fly. According to G. Monteith no specimen has been found in the large series of flight intercept traps that were run during the sample periods. Hence, species of *Philipis* apparently fly very rarely. But flight may be of no

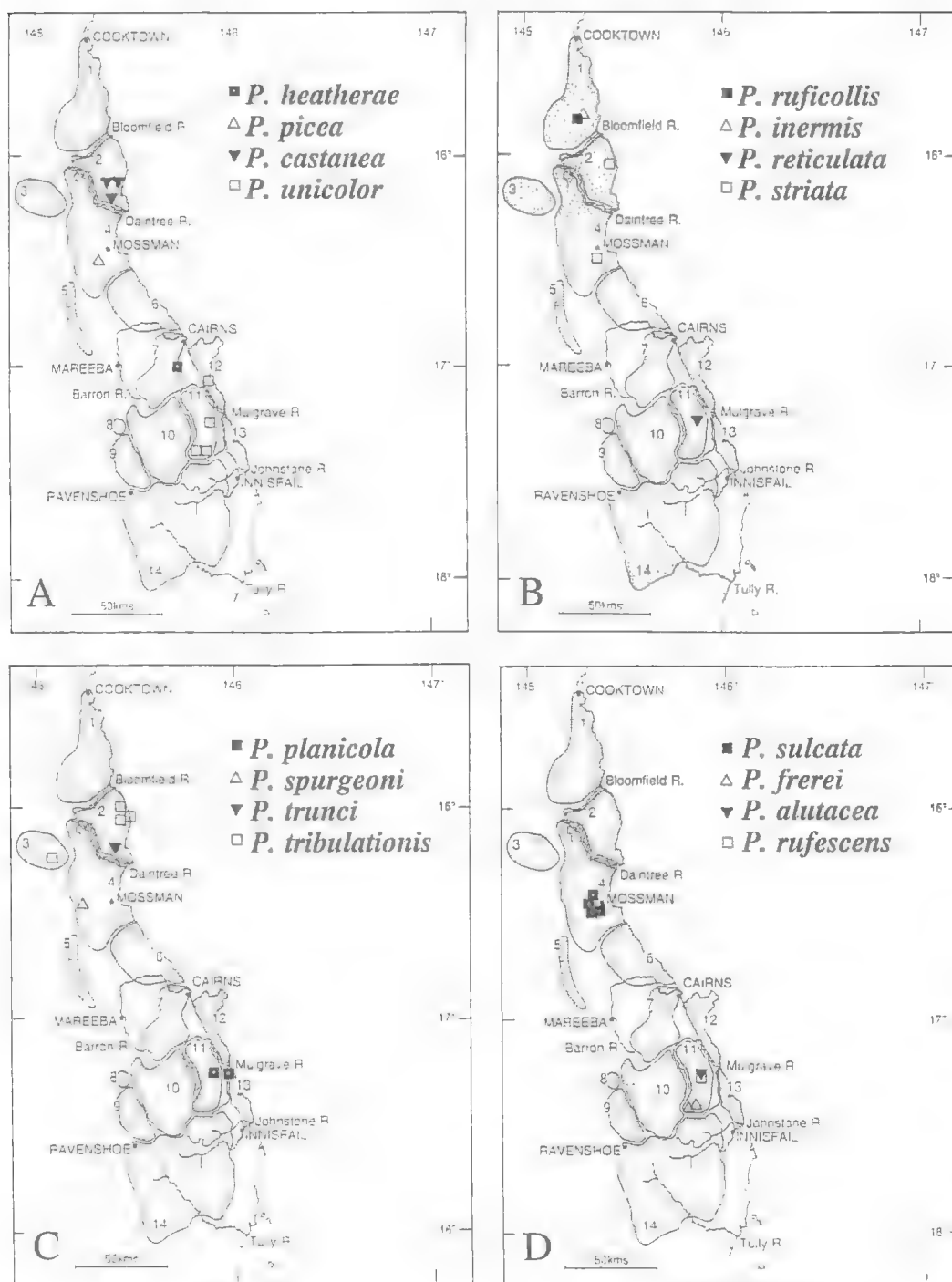


FIG. 18. Distribution of *Philipis* species. A, *P. heatherae* sp. nov., *P. picea* sp. nov., *P. castanea* sp. nov. and *P. unicolor* sp. nov. B, *P. ruficollis* sp. nov., *P. inermis* sp. nov., *P. reticulata* sp. nov. and *P. striata* sp. nov. C, *P. planicola* sp. nov., *P. spurgeoni* sp. nov., *P. trunci* sp. nov. and *P. tribulationis* sp. nov. D, *P. sulcata* sp. nov., *P. frerei* sp. nov., *P. alutacea* sp. nov. and *P. rufescens* sp. nov.

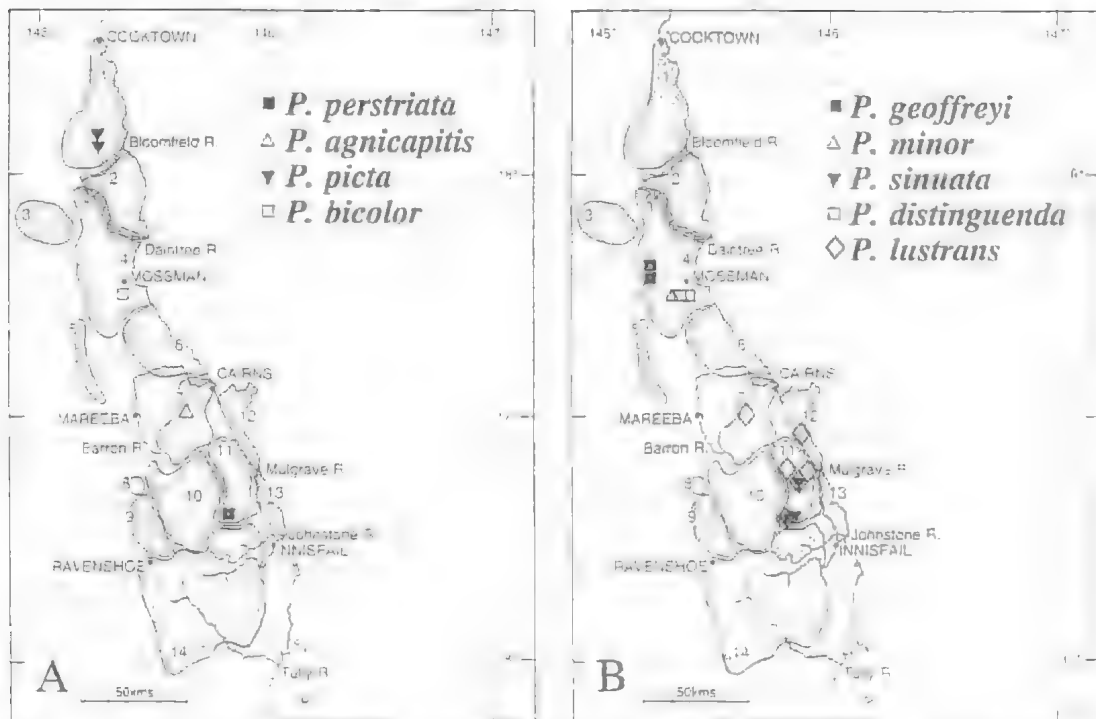


FIG. 19. Distribution of *Philipis* species. A, *P. perstriata* sp. nov., *P. agnicapitis* sp. nov., *P. picta* sp. nov. and *P. bicolor* sp. nov. B, *P. geoffreyi* sp. nov., *P. minor* sp. nov., *P. sinuata* sp. nov. and *P. lustrans* sp. nov.

advantage for beetles living in dense montane rainforest. Many species, however, possess reduced wings and are flightless.

Nothing is known on habits and life cycles, on diet, enemies, mating and reproduction, and no larvae have been detected. Since none have been seen running about, nothing is known on the daily period of activity, perhaps they are rather nocturnal.

On several occasions, and even within the same samples, different species have been observed occurring together. However it is unknown, whether they were from the same tree, because most samples include material from several trees. Nothing is also known about their possible preference for different tree or moss species.

A striking feature that will be important for the following biogeographical treatment is the occurrence of almost all species (except for *P. planicola* and *P. striata*) in montane rainforest mainly above 900m. A further feature is the extremely limited ranges of most species that have been observed usually on only a single mountain top, far less commonly on a mountain range or on a group of adjacent ranges. Only one species (*P. thompsoni*) occupies a really wide range through-

out a larger part of the overall wet tropics region of north Queensland.

In conclusion it must regrettably be stated that we still know extremely little about the natural history of these beetles in spite of the enormous collecting efforts of Geoffrey Monteith and his co-workers.

RECONSTRUCTED PHYLOGENY

PHYLOGENETIC STATUS

Philipis is a genus of basically plesiomorphic tachyine beetles which nevertheless shows some specialized or apomorphic characters. Erwin (1973) when revising the similarly partly arboreal neotropical *Xystosomus*, noted some of these primitive characters that are likewise present in the Australian *Philipis*. In a numerical cladistic analysis of the higher categories of Bembidiini - using the Hennig 86 program - Erwin (pers. comm.) found that *Philipis* keys out as the sister group of all the New World xystosomines. This would affirm the plesiomorphic status and perhaps also the close relationship of both lineages because plesiomorphic species of the *Xystosomus* lineage exhibit some character states present only

TABLE 2. Character states and their phylogenetic value in *Philipis*.

	Character	plesiomorphic	apomorphic
1	Size	medium-sized to large	very small
2	Shape of elytra	elongate, depressed	short, convex 2' - very short and highly convex
3	Surface of elytra	even	impressed in anterior third
4	Number of elytral striae present	all striae present and well developed	7th-5th striae reduced, less distinct 4' - 7th-5th striae absent 4'' - only two inner striae present 4''' - only sutural stria present
5	Length of striae	striae fully developed	striae posteriorly shortened
6	Depth of striae	striae deeply impressed	only inner 4 striae impressed 6' - only inner 3 striae impressed 6'' - only inner 2 striae impressed 6''' - only sutural stria impressed
7	Puncturation of striae	striae punctate	striae impunctate
8	Shape of striae	2nd-7th striae normally shaped	all striae deeply sulcate
9	Apical striae	elongate, curved inwards, meets 3rd stria	shortened, not curved inwards, not meeting 3rd stria
10	Microreticulation of pronotum	present, distinct	reduced or absent
11	Microreticulation of elytra	present, distinct	reduced, superficial 11' - completely absent
12	Colour of pronotum	blackish-piceous	reddish, contrasting
13	Colour of elytra	blackish-piceous	13a - reddish 13b - deep black
14	Elytral pattern	present, consisting of an apical macula	14a - present, consisting of a basal and an apical macula each 14b - absent
15	Shape of posterior elytral macula	circular or slightly transverse	elongate, oblique 15' - markedly s-shaped 15'
16	Distinctness of elytral maculae	rather inconspicuous	distinct, sharply bordered 16' - accentuate, set off by a conspicuous dark background
17	Colour of sutural interval	unicolourous	contrastingly reddish
18	Colour of space around discal elytral punctures	unicolourous	contrastingly light
19	Aedeagus	normal shaped, with short apex, lower surface straight	19a - apex elongate 19b - lower surface sinuate or bisinuate 19c - very short, compact, curved 19d - apex elongate, slender, at base incised

in *Bembidion* sensu lato, but generally not in Tachyini. Should this close relation be proved, this would have a major impact on biogeographic and evolutionary questions of the tribe Tachyini in general.

PHYLOGENETIC RELATIONS

Certainly all species of *Philipis* are closely related as indicated by their uniform appearance, colour, pattern, and external and genitalic morphology. Hence it is difficult to deal with the phylogenetic relations at the specific level, because parallel evolution presumably has been a very common event, and, on the other hand, striking morphological differences are rare and present only in few highly aberrant species. In my

attempted evaluation of phylogenetic relations, several morphoclines from plesiomorphic to more or less highly apomorphic states were found, but in many cases it is obvious that evolution of a comparable or even the same apomorphic character status has occurred twice or even several times. In other characters it is still uncertain, whether apomorphic stages of the morphocline are synapomorphic, i.e. whether species exhibiting the same apomorphic character states are actually related. Such states which have been certainly evolved independently are marked with numbers in the character matrix below.

For better comparison a summary of the measures and ratios of all species is included that

illustrates some of the differences in size and body shape (Table 1). Although the characters used and their presumed plesiomorphic and apomorphic states are shown in Tables 2 & 3, some characters, especially those that build up morphoclines, are explicitly discussed below.

1. *Size*. Comparison with other genera of Tachyini, especially *Xystosomus* and allies, convinces me that very small size is apomorphic rather than plesiomorphic. Small size may be advantageous for a beetle living in the often short moss growing on tree trunks. Size reduction may have occurred repeatedly in different lineages of the genus.

2. *Shape of elytra*. The more elongate, depressed shape of the elytra in the *quadraticollis*-group (*P. quadraticollis*, *P. cooki*, *P. laevigata*, *P. alticola*, *P. heatherae*, and, to a lesser degree, also *P. castanea* and *P. picea*) is presumably the plesiomorphic state, and the short and usually highly convex elytra of certain species - best evolved in *P. sulcata* - are apomorphic. Furthermore the convex shape of the elytra is commonly combined with reduction of elytral striation and extensive reduction or even complete loss of microreticulation, which are both likewise apomorphic states. The tendency to evolve a rather globular body shape is perhaps generally common to moss- and fungus-inhabiting beetles. But which advantage the smooth, glossy integument should bear, is uncertain. Perhaps it has a water-repellent function.

4-8. *Development of elytral striae*. Certainly the full set of elytral striae is the plesiomorphic state, as in other genera. Complete reduction of striae, or shortening at base and apex, or reduction of depth of striae are therefore apomorphic states that make up morphoclines to the final state, where only the sutural stria is present. Originally the striae are punctate or punctate-crenulate, therefore reduction of puncturation, but at the same time channelling of all striae, are different apomorphic states that may eventually lead to elytra that have all striae deeply channelled but impunctate. Reduction of striae is commonly combined with loss of microreticulation, but in some species it is not. All these reductions presumably occurred independently in different lineages, without our exact knowing of how many times they occurred.

9. *Form of apical striae*. Although the lateral position of the apical striae is presumably a plesiomorphic character of the whole genus, the plesiomorphic state within the genus may be a curved apical striae that meets the 3rd stria or its

position. The almost straight, barely incurved striae in some species may be therefore a secondary, apomorphic state.

10, 11. *Loss of microreticulation*. Certainly apomorphic, but it may be due to parallel evolution, like most other reductions, in several species.

12, 13. *Colour of surface*. Uniformly piceous or blackish colour is perhaps the plesiomorphic state, whereas vivid colouration of pronotum and/or elytra are apomorphic states, the advantage of which, however, is obscure.

14-18. *Elytral pattern*. It is uncertain, whether unspotted or uniplagiate elytra are the plesiomorphic status in *Philipis*, since there are good reasons for both opinions. Out-group comparison of the closest relatives reveal that species of the *Xystosomus* lineage are generally unspotted, but in some other tachyine genera presence of an apical spot seems to be the plesiomorphic status. In the species of the apomorphic species group of *Philipis* that combines rather short, convex species, however, both unspotted species (*P. unicolor*, *P. atra*) are in some other respects rather apomorphic (markedly short, convex body shape, reduction of striation, absence of microreticulation). In these species at least loss of elytral pattern is perhaps secondary.

The plesiomorphic state of the elytral pattern when it is present is certainly the unimaculate one, with the apical macula about circular or at most vaguely transverse. The bimaculate pattern and the various oblique to markedly s-shaped forms of the apical macula, and the pronounced colour of the maculae on a dark background are apomorphic states that in some lineages form morphoclines. Conspicuous colourations of suture and of discal punctures are found in single species only and are special features of these species.

Therefore, the basic branching of the cladogram is rather dependent on deciding whether absence of elytral pattern is plesiomorphic or apomorphic. Thus a basic branching different from that chosen in the cladogram cannot be completely excluded, although it seems to me less probable.

19. *The aedeagus*. Basically very similar throughout the genus. Some unusual modifications of shape and form of apex are apomorphic, but may be special features or autapomorphic states of single species only and thus of little value for the reconstruction of the phylogenetic relations.

TABLE 3. Character states in the species of *Philipis*, numbered as in Table 2. -: plesiomorphic state; 1, 2 etc.: apomorphic state, different apomorphic states distinguished by lower case letters. States of a morphocline indicated by: ', ', '. Comparable or similar apomorphic states that have been likely convergently evolved are marked by numbers: 1, 2 etc.

<i>Philipis</i> species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
<i>quadraticollis</i>										10	11				15 ¹				
<i>alticola</i>			3	4	5	6'									15 ¹				
<i>cooki</i>			3	4'	5	6''				10	11				15 ¹				
<i>laevigata</i>			(3)	4'	5	6	7 ¹			10	11				15 ¹				
<i>heatherae</i>				4'	5	6'''				10	11				15 ¹				
<i>picea</i>					5	6''				10	11'			14b ¹					
<i>castanea</i>				4'	5	6'''				10	11'			14b ¹					19a ¹
<i>unicolor</i>	1 ¹	2 ¹		4''	5	6''				10	11'			14b ²					
<i>atra</i>		2		4		6''			9 ¹	10	11'		13b	14b ²					19a ²
<i>ruficollis</i>		2 ²		4'	5	6''				10	11'	12 ¹							19b ¹
<i>inermis</i>	1 ²	2		4'	5	6''			9 ²								16 ¹		
<i>reticulata</i>		2								10					15 ¹	16 ¹			
<i>striata</i>		2				6				10	11'				15 ¹	16 ¹			
<i>planicola</i>	1 ³	2		4	5	6'				10	11'				15 ¹	16 ¹			
<i>spurgeoni</i>		2		4	5	6'				10	11				15 ¹	16 ¹			
<i>trunci</i>	1 ⁴	2		4'	5	6''				10	11'				15 ¹	16 ¹			19a ³
<i>tribulationis</i>	1 ⁴	2		4	5	6''				10	11'				15 ¹	16 ¹			19a ³
<i>thompsoni</i>		2		4'	5	6''				10	11'				15 ¹	16 ¹			19a ³
<i>vicina</i>		2		4	5	6''				10	11'				15 ¹	16 ¹			19a ³
<i>laevis</i>		2 ³		4''	5	6'''			9 ³	10	11'			14a					19a ⁴
<i>vulcata</i>		2 ³						8 ¹		10	11'			14a				18 ¹	19d
<i>freiei</i>		2									11	12 ²		14a					19a ⁵
<i>subtropica</i>		2		4'	5	6''				10	11'			14a					19a ⁵
<i>alutacea</i>		2		4	5	6''	7 ²							14a					19b ²
<i>rufescens</i>		2					7 ³					12 ³	13a ¹	14a	15 ²	16 ²			
<i>perstriata</i>	1 ⁵	2					7 ¹	8 ²			11	12 ³		14a	15 ²				
<i>elliotti</i>	1 ⁶	2		4	5	6				10	11'	12 ⁴		14a	15 ²	16 ³			
<i>agnicapitis</i>		2		4		6				10	11			14a	15 ²	16 ³			
<i>picta</i>		2		4'	5	6''				10	11'	12 ⁵	13a ²	14a	15 ²	16 ⁴			19c
<i>bicolor</i>		2		4	5	6				10	11	12 ⁵		14a		16 ⁴	17	18 ²	
<i>geoffreyi</i>	1 ⁷	2		4	5	6				10	11			14a	15 ²	16 ³			
<i>minor</i>	1 ⁷	2		4'	5	6'				10	11			14a	15 ²	16 ³			
<i>sinuata</i>		2		4	5	6								14a	15 ²	16 ⁵			
<i>distinguenda</i>		2			5	6				10	11			14a	15 ²	16 ⁵			19b ³
<i>lustrans</i>		2			5	6				10	11'			14a	15 ²	16 ²			19b ³

The cladogram (Fig. 9) erected on the basis of these character states seems to give quite good results but extreme caution is required during interpretation, because it certainly has some parallelisms. Also, some of the opinions expressed below are based on mere similarities rather than on well founded synapomorphies. On the other

hand, some branchings are certainly disputable due to the validity of the supporting synapomorphies. The character of the cladogram is thus highly speculative, as may also be seen by the existence of several trichotomies or polytomies. Therefore some groupings that seem better founded are explicitly discussed below.

1. *quadraticollis*-group. The five species of this group apparently combine mostly plesiomorphic character states, hence it is uncertain whether they are really closely related. Perhaps they constitute a cluster of more or less primitive species. Within the group *P. cooki*, *P. laevigata*, and *P. alticola* are perhaps closely related, and they are perhaps also related to *P. heatherae*. *P. quadraticollis*, on the other hand, is presumably the most plesiomorphic species of this group and of the whole genus.

2. *picea*-group. Both unpatterned though still elongate species *P. picea* and *P. castanea* are perhaps more highly evolved than the species of the *quadraticollis*-group and form a distinct group of uncertain affinities. All other species are perhaps related by their more or less short and convex shape of the elytra. They divide into three distinct groups, the *unicolor*-, *trunci*-, and *sinuata*-groups, respectively, the relationships of which, however, are fairly obscure.

3. *unicolor*-group. The two unpatterned species *P. unicolor* and *P. atra* form a monophyletic unit, when absence of pattern is actually an apomorphic state. *P. ruficollis* is a rather isolated species but may be next related to both.

4. *trunci*-group. The unimaculate species of the *trunci*-group perhaps form a monophyletic group, although this is at present based on a rather weak character. Certainly, however, this group includes the most plesiomorphic species within all patterned species excluding those of the *quadraticollis*-group, which is *P. reticulata*. *P. inermis* does not fit well in this group and possesses several autapomorphic character states. Apart from its unimaculate elytral pattern, it does not share many characters with the rest of the species of the *trunci*-group. These, however, are all combined by the synapomorphic, s-shaped form of the elytral spot.

Within this latter assemblage *P. trunci*, *P. tribulationis*, *P. thompsoni*, and *P. vicina* are closely related and apparently constitute a monophyletic group. *P. planicola* and *P. spurgeoni* may be slightly less apomorphic, but are related to the above group by some apparent synapomorphic character states. All these species combine perhaps to be the sister group of *P. striata*, and together with *P. striata* they form the sister group of *P. reticulata* which seems to represent the most primitive species of the whole *trunci*-group.

5. *sinuata*-group. The rest of the species from *P. laevis* apparently form again a monophyletic unit, though the relationships within this group

are highly speculative. *P. laevis* and again *P. sulcata* are highly specialized, autapomorphic species that may be related, but whose relationships are obscure. *P. frerei*, *P. alutacea*, and *P. subtropica* may form a separate group which is perhaps the more primitive sister group of the rest of the species. *P. frerei* and *P. subtropica* share the apparently synapomorphic shape of the aedeagus, but the three mentioned species may be actually not very closely related.

The remaining species presumably form a fairly well-defined monophyletic group. *P. perstriata* and *P. rufescens* may be related to one another, but both are fairly aberrant species, perhaps rather remotely related to the rest of species, whereas all other species may form a monophyletic unit. *P. ellioti* and *P. agnicapitis* may be in some respects more plesiomorphic than the remaining species which all possess a markedly sinuate apical elytral spot. Certainly *P. picta* and *P. bicolor* are closely related due to their similar, highly complex pattern. *P. geoffroyi* and *P. minor* may form another group, but this is uncertain. The last three species (*P. sinuata*, *P. distinguenda*, and *P. lustrans*) are again closely related and are distinguished only by minor characters of shape, microreticulation, pattern, and structure of aedeagus.

To conclude, the present 35 species can presumably be referred to only five different stocks, three of which are perhaps more closely related to each other, than any to the *quadraticollis*-group.

DISTRIBUTION

Despite of the large number of recorded species, the material is still insufficient for a final review of the distributions. Many species are still known from a single locality or mountain top without our knowing whether this apparent limited range is due to inappropriate sampling, or whether it reflects the actual range. Therefore, any considerations about ranges and why the ranges of certain species differ to such large extent are somewhat hypothetical.

Nevertheless, I have tried to point out the current knowledge of the species ranges in the following tables which list altitude ranges (Table 4) and the recorded species for each locality (Table 5). The known localities are also depicted in maps that are based on a subdivision of the wet tropics region of north Queensland in 19 different mountain/rainforest blocks according to the classification used by G. Monteith for his survey of the rainforest fauna of north Queensland (Fig.

TABLE 4. Recorded altitude range of known species of *Philipis* (altitudes below 500m in bold type).

Species	altitude	Species	altitude
<i>quadraticollis</i>	1000-1180m	<i>vicina</i>	850m
<i>alticola</i>	1560m	<i>laevis</i>	1000-1300m
<i>cooki</i>	1100-1330m	<i>sulcata</i>	480 -1300m
<i>laevigata</i>	1100-1250m	<i>frerei</i>	1500-1620m
<i>heatherae</i>	1050m	<i>subtropica</i>	1100-1400m
<i>picea</i>	860m	<i>alutacea</i>	1500-1560m
<i>castanea</i>	780-1300m	<i>rufescens</i>	1500-1560m
<i>unicolor</i>	900-1440m	<i>perstriata</i>	1620m
<i>atra</i>	900m	<i>elliotti</i>	1000-1150m
<i>ruficollis</i>	850-1100m	<i>agnicapitis</i>	1200m
<i>inermis</i>	1100m	<i>picta</i>	1050-1100m
<i>reticulata</i>	1000m	<i>bicolor</i>	1100m
<i>striata</i>	150 -600m	<i>geoffreyi</i>	1250-1300m
<i>planicola</i>	5 -100m	<i>minor</i>	1180m
<i>spurgeonii</i>	1330m	<i>sinuata</i>	1500-1620m
<i>trunci</i>	1000-1300m	<i>distinguenda</i>	480 -1200m
<i>tribulationis</i>	680-1225m	<i>lustrans</i>	950-1200m
<i>thompsoni</i>	700-1250m		

17B). Each rainforest block is defined by more or less natural barriers as depicted in the maps. In a final list the occurrence of the species in these rainforest blocks is listed (Table 6). As a summary of those lists and maps the following conclusions may be drawn:

1. 33 of 35 known species occur in northeastern Queensland, especially in the mountains at the eastern fringes of the Atherton and Carbine Tablelands. The northern border of the range of the genus is on Mt. Finnigan, south of Cooktown. South of the tablelands few species occur on some scattered mountain tops only (Mt. Macalister, Mt. Elliot, Mt. Macartney, Lamington Plateau, Springbrook Plateau). Surprisingly enough, no *Philipis* has been thus far recorded on the prominent plateaus of Mt. Spec south of Ingham and Eungella west of Mackay, although G. Monteith has sampled both plateaus. Hence the main centre of diversity of the genus is certainly the Carbine Tableland and the Bellenden Ker Range of north-eastern Queensland.

2. Almost all species occur in montane rainforest above about 900m, and only two species (*P. planicola*, *P. striata*) have been recorded at or near sea level, whereas another two species extend as far down as about 500m. But in the respective areas this is already at the level where montane rainforest exists. Many species occur

regularly above 1000m, and surprisingly many species live only on the highest tops of the respective mountains. On Bellenden Ker and Bartle Frere for example, those species apparently do not descend below 1500m. Thus *Philipis* is primarily a genus of montane species and the few lowland species have probably reached this level secondarily.

3. Of 35 recorded species, 23, that is more than two thirds, are from a single locality or mountain top (Table 5). They are especially common on the isolated tops of Mt. Finnigan, Thornton Peak, Mt. Spurgeon, on the Carbine Tableland, on Mt. Bellenden Ker and Mt. Bartle Frere, and again in the southern part of the range of the genus. On the Atherton Tableland, on the other hand, only one widespread species (*P. thompsoni*) occurs but only on the mountains that make up the western border of the tableland. A single apparently endemic species has been found on the Lamb Range at the eastern fringe of the Tableland. So the fauna of the Atherton Tableland is surprisingly poor and is therefore in sharp contrast to the ranges east of the tableland with their rich, endemic faunas.

Three species (*P. castanea*, *P. cooki*, *P. sulcata*) that have been collected at several localities, nevertheless occur on a single range or tableland only (Cape Tribulation-Thornton Peak area, and Carbine Tableland area, respectively). At the current state of knowledge they are endemic to the respective range.

Three further species (*P. striata*, *P. tribulationis*, *P. sinuata*) occur on two adjacent ranges or tablelands which are separated by a river or creek valley that reaches below 500m. The first two species live in the Cape Tribulation and Windsor Tableland, and Cape Tribulation and Carbine Tableland areas, respectively, which are both separated by the Daintree River. *P. sinuata* occurs on Mt. Bellenden Ker and Mt. Bartle Frere that belong to a common range, but are separated by the deeply incised valley of Babinda Creek in the Babinda area. Actually *P. sinuata* occurs only at high altitude (above 1500m) on both mountain tops. A further species, *P. quadraticollis*, is somewhat enigmatic, because it has been found on the Carbine Tableland and again in the Massey Range at the western slope of the Bellenden Ker Range. This is indeed a very wide gap, but the single two known specimens of this species are both females, therefore I am not entirely convinced that they are actually conspecific.

Another two species (*P. lustrans*, *P. unicolor*) occur on several adjacent ranges (Malbon

Thompson Range, Lamb Range, Massey Range, Bellenden Ker Range, or Malbon Thompson Range, Bellenden Ker Range, and Mt. Bartle Frere, respectively) that are separated by the Mulgrave River, Little Mulgrave River, and Babinda Creek valleys, respectively, but nevertheless are part of a former common tableland.

One species, *P. planicola*, is outstanding, because it has been recorded only at very low altitude in the eastern foothills of the Bellenden Ker Range, where it is an inhabitant of lowland rainforest. Even so this species seems to be localized in this area.

Only a single species (*P. thompsoni*) is really wide-ranging. It occurs on almost all ranges surrounding the Atherton Tableland from Kuranda in the north, but not in the Bellenden Ker and Bartle Frere ranges at the eastern border of the tableland. It extends beyond the Atherton Tableland to the south in the Tully area and further south in the Cardwell Range.

In conclusion it should be stressed that almost all species are endemic to one mountain top or range, or limited to a system of adjacent ranges or tablelands that certainly formed previously a common range. However, only one species is actually widespread, and another, somewhat dubious species occurs apparently on two widely separated ranges. By far most species occur in the Carbine and Bellenden Ker/Bartle Frere rainforest blocks (Fig. 10), remarkably fewer in the isolated Finnigan and Thornton blocks, in the Lamb Range block west of Cairns, and on the coastal Malbon Thompson Range, but single species only are scattered through the other rainforest zones.

A similar general distribution pattern has been found in flightless, ground-living carabids that inhabit montane rainforest, namely of the genera *Notonomus* and *Trichosternus* (Darlington 1961a, b), and according to G. Monteith (pers. comm.) also in the (likewise flightless) Tenebrionidae of the subfamily Adeliinae, and in Aradidae. These are all groups of low agility that inhabit either the forest floor or tree trunks and logs. In all groups the Bellenden Ker Range and the Carbine Tableland possess by far the richest fauna of endemic species, whereas some species of the Atherton Tableland are widespread and occur on several mountain tops. Hence this distribution pattern and the underlying biogeographical events are very similar in several insect groups of low vagility including *Philipis*.

TABLE 5. List of localities and the respective recorded species (species occurring on a single locality or mountain top printed in bold types).

Mt. Finnigan	<i>ruficollis</i> , <i>inermis</i> , <i>picta</i>
Mt. Misery	<i>vicina</i>
Cape Tribulation	<i>castanea</i> , <i>striata</i> , <i>tribulationis</i>
Thornton Peak	<i>castanea</i> , <i>trunci</i> , <i>laevis</i>
Windsor Tableland	<i>tribulationis</i>
Carbine Tableland	<i>cooki</i>
Mt. Spurgeon	<i>laevigata</i> , <i>spurgeoni</i> , <i>geoffreyi</i>
Devils Thumb	<i>quadraticollis</i> , <i>cooki</i> , <i>sulcata</i>
Plane Crash Site	<i>sulcata</i>
Mossman Bluff & Track	<i>cooki</i> , <i>picea</i> , <i>striata</i> , <i>sulcata</i> , <i>minor</i> , <i>distinguenda</i>
Pauls Luck	<i>sulcata</i>
Mt. Demi	<i>cooki</i> , <i>bicolor</i>
Mt. Lewis	<i>cooki</i>
Mt. Formartine South	<i>thompsoni</i>
Lambs Head	<i>agnicapitis</i> , <i>lustrans</i>
Emerald Creek	<i>thompsoni</i>
Mt. Edith	<i>thompsoni</i>
Isley Hills	<i>heatherae</i> , <i>thompsoni</i>
Mt. William	<i>thompsoni</i>
Bell Peak North	<i>unicolor</i> , <i>lustrans</i>
Mt. Bellenden Ker	<i>alticola</i> , <i>unicolor</i> , <i>reticulata</i> , <i>alutacea</i> , <i>rufescens</i> , <i>sinuata</i> , <i>lustrans</i>
Massey Range	<i>quadraticollis</i> , <i>thompsoni</i> , <i>lustrans</i>
Bellenden Ker Range foothills	<i>planicola</i>
Russell River	<i>planicola</i>
Mt. Bartle Frere	<i>unicolor</i> , <i>frerei</i> , <i>perstriata</i> , <i>sinuata</i>
Baldy Mt.	<i>thompsoni</i>
21 km S. Atherton	<i>thompsoni</i>
Hugh Nelson Range	<i>thompsoni</i>
Mt. Fisher	<i>thompsoni</i>
Mt. Father Clancy	<i>thompsoni</i>
Upper Boulder Creek	<i>thompsoni</i>
Mt. Macalister	<i>thompsoni</i>
Mt. Elliot	<i>elliotti</i>
Mt. Macartney	<i>atra</i>
Lamington Plateau	<i>subtropica</i>
Springbrook Plateau	<i>subtropica</i>

BIOGEOGRAPHY

Philipis is essentially tropical. However, it is a phylogenetically plesiomorphic and, therefore, old genus, perhaps closely related to the, likewise tropical South American *Xystosomus* lineage. If that phylogenetic status is right, according to its

TABLE 6. Mountain/rainforest blocks of north Queensland and the recorded species of *Philipis* (for names of zones see Fig. 17B. Two species (*P. atra* and *P. subtropica*) do not occur within the tabulated area.

<i>Philipis</i> species	1	2	3	4	6	7	8	9	11	12	13	14	15	19
<i>quadraticollis</i>				X					X					
<i>alticola</i>									X					
<i>cooki</i>				X										
<i>laevigata</i>				X										
<i>heatherae</i>						X								
<i>picea</i>				X										
<i>castanea</i>		X												
<i>unicolor</i>		X							X	X				
<i>ruficollis</i>	X													
<i>inermis</i>	X													
<i>reticulata</i>									X					
<i>striata</i>		X		X										
<i>planicola</i>									X		X			
<i>spurgeoni</i>				X										
<i>trunci</i>		X												
<i>tribulationis</i>		X	X											
<i>thompsoni</i>					X	X	X		X			X	X	
<i>vicina</i>	X													
<i>laevis</i>		X												
<i>sulcata</i>				X				X						
<i>frerei</i>									X					
<i>alutacea</i>									X					
<i>rufescens</i>									X					
<i>perstriata</i>									X					
<i>elliotti</i>														X
<i>agnicapitis</i>						X								
<i>picta</i>	X													
<i>bicolor</i>				X										
<i>geoffreyi</i>				X										
<i>minor</i>				X										
<i>sinuata</i>									X					
<i>distinguenda</i>				X										
<i>lustrans</i>						X				X				
summary	4	5	1	11	1	4	1	1	12	2	1	1	1	1

distribution *Philipis* may constitute a part of the ancient tropical-subtropical "old Gondwanan faunal element" (Howden, 1981; Baehr, 1990b). Nevertheless, it is unknown where and in which environment the original stock of *Philipis* survived in Australia during the very long time of changing environmental conditions of the late Mesozoic and early Tertiary periods.

Although the genus is widely distributed, the most plesiomorphic species still occur in north-

eastern Queensland. Hence, the genus may always have lived in more or less tropical rainforest. It is unknown, however, whether the moss-inhabiting way of life is the original one, or has been adopted later. It is likewise unknown, whether the genus has been always as montane as it is today, since most ranges and tablelands that it inhabits at present have been built up or uplifted comparatively recently, during the Pliocene and Pleistocene.

Phylogenetic evidence reveals the existence of two main present centres of diversity and species richness, namely the Carbine Tableland and the eastern fringe of the Atherton Tableland (especially the Bellenden Ker and Bartle Frere ranges), with several pairs of rather closely related species occurring in both areas (*P. cooki*-*P. alticola*, *P. striata*-*P. planicola*, *P. tribulationis*-*P. thompsoni*, *P. distinguenda*-*P. sinuata*). The species that are presumably most plesiomorphic also occur in these areas. Within both areas the degree of endemism is fairly low because several species occur on adjacent ranges or tablelands, but almost no species occurs in both areas. The single exception is *P. quadraticollis* that occurs on the Carbine Tableland and in the Bellenden Ker Range. It is perhaps the most plesiomorphic species of the whole genus, but the specific status of both populations (that are both known by only a single female specimen) is not yet fully settled.

From the Carbine Tableland the rather isolated mountain tops of Mt. Spurgeon, Thornton Peak, and Mt. Finnigan (as well as Mt. Misery) have been colonized. All three tops are inhabited by three species endemic to the respective mountain, but the fauna of the most isolated Mt. Finnigan is phylogenetically most isolated, because *P. ruficollis* and *P. inermis* do not possess a close relative, and the third species, *P. picta*, is related to *P. bicolor* of Mt. Demi only. The faunas of Thornton Peak and Mt. Spurgeon, on the other hand, are more closely related to those of the eastern parts of Carbine Tableland. The species which occur on all three tops however belong to different stocks, thus showing that there have been three different colonisation or speciation events on each top although those on Mt. Finnigan were perhaps the oldest.

In the ranges at the eastern fringe of the Atherton Tableland the situation is rather simple with: (1). Some species inhabiting several adjacent ranges (Lamb Range, Malbon Thompson Range, Bellenden Ker Range); (2). Additional species with a slightly more limited range; (3). Some species occurring only on the Bellenden Ker Range; and (4). Several species endemic to either Mt. Bellenden Ker or Mt. Bartle Frere. This distribution pattern may reflect populations of different age that have been isolated to a different degree. In the southern part of the range of the genus the species density is low, but as in the northern part of the range, all species are endemic to a single mountain top and most are more or less closely related to a species occurring further north.

Although the phylogenetic analysis is not conclusive, it seems as if the faunas of both Carbine Tableland and of the ranges at the eastern fringe of Atherton Tableland are composed of both fairly wide-ranging, rather plesiomorphic species and usually endemic, apomorphic species with limited ranges. With regard to the existence of some pairs of closely related species in both areas, it may be suggested that the former ranges of the stocks of several recent species have been wide and have been rather recently interrupted.

According to the patterns of distribution, the phylogenetic evidence, and the known paleogeographic, climatic, and floristic history of north-eastern Australia, the history of the genus may be thus hypothesized as following: *Philipis* is an old and in certain respects very plesiomorphic genus that lived presumably always under subtropical and perhaps even tropical conditions in rainforest and may be a part of the so-called "Old Gondwanan element", because its nearest relative is perhaps the tropical South American *Xystosomus* lineage. However, most species seem to be young according to their very similar external and genitalic structures. The high species diversity of the genus may be thus a rather recent event and may be caused by the combination of three geologic and climatic factors:

(1) Uplift of much of the Great Dividing Range during Pliocene and Pleistocene and its following disintegration into more or less isolated tops and tablelands due to rapid erosion.

(2) Gradual climate change of Australia to a warmer and drier climate with more pronounced dry seasons as the Australian block drifted northwards. While lowlands became drier and hotter and less favourable for rainforest living animals, mountain tops remained cooler and wetter because of the altitude and of orographic rains from the nearby sea.

(3) Repeated and more radical climatic changes during the "ice age" when rainforests retreated up the mountains to form small, isolated, pockets during glacials when the sea level was low and the mountains were far away from the coast, and descended again during the interglacials to become more or less continuous forests.

The effects of all three events were superimposed on a gradual retreat of the rainforest to the mountain tops and a general isolation of rainforest pockets during late Tertiary and the Pleistocene glacials, interrupted only by a temporary but repeated spreading of rainforest during the Pleistocene interglacials. It seems that these

climatic and floristic events repeatedly separated and rejoined formerly wide species ranges, that can be postulated for example for the Carbine Tableland and the mountains east to the Atherton Tableland on the basis of several pairs of closely related species occurring in both areas, and thus supported allopatric speciation on single mountain tops or ranges by geographical isolation. As a consequence, more than two thirds of the extant species are endemic to a single mountain top. According to phylogenetic data, the present 35 species can be referred to only 5 original stocks, representatives of which occur in both main centres. Hence speciation presumably occurred mainly by vicariance of populations separated by uplifting of ranges or tablelands, either due to development of barriers through rapid erosion of formerly more homogenous areas, or to dismembering and isolation of formerly continuous rainforest areas due to climatic changes.

At the northern and southern borders of the range however, some speciation may have occurred by colonisation of isolated tops rather than by parainsular reproductive isolation.

Main speciation events (producing the present species) perhaps occurred as late as during Pleistocene, whereas less ample speciation (which perhaps led to the founding species of the main species groups or of the main branchings within the species groups) occurred in late Tertiary.

In this context the question arises, whether the species of this genus had been formerly as "montane" as they are at present, or whether they have trapped on the mountain tops, where they still persist. If *Philipis* is actually an old genus and at the same time an "Old Gondwanan element", then it lived for a long period under warm temperate to subtropical circumstances, until Australia - presumably at the end of Miocene - finally arrived at its present position. Only then the genus or the original stocks may have adapted to tropical climate. Therefore, it is conceivable that the genus escaped full tropical conditions in refugia on the highest mountain tops with their more temperate climatic conditions. On these reasons I believe, that the genus has been montane for a long time, and that its present montane, moss-living habits are old.

ACKNOWLEDGEMENTS

I thank Mr. C. Vogt (Cambridge/Massachusetts) and Mr. T. Weir (Canberra) for the kind loan of types and specimens. Special

thanks are due to Dr. G. Monteith (Brisbane) who, assisted by his colleagues Doug Cook, Heather Janetzki, and Geoff Thompson, collected almost all specimens studied and kindly loaned them for examination. Geoff Monteith provided critical comments on the manuscript while Karin Koch assisted in its editing. Geoff Thompson carried out the excellent full illustrations in Figs 2 and 3.

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COMMUNAL NESTING IN THE SMALL SKINK, *LAMPROPHOLIS ADONIS*. *Memoirs of the Queensland Museum* 38(2)382. 1995:- Communal nesting is well-known amongst *Lampropholis* spp. It has been observed frequently in two species, *L. delicata* and *L. guichenoti* (Greer, 1989 & references therein). Its occurrence in the recently described *L. adonis* Ingram, 1991, is therefore predictable.

On 12 November, 1994, a communal nest (Fig. 1) containing 53 skink eggs was found in Bulburin State Forest (24°31'S, 151°29'E). The eggs had been laid in a pocket of insect frass and decaying vegetation between sheets of corrugated iron. The 'nest' was in a small, well-shaded clearing in complex notophyll vine forest, 5m from the forest's edge. *L. adonis* was the most abundant skink species at this site. Several specimens of this species were seen beneath the corrugated iron, and had been observed at this locality previously, associated with a communal nest (S. Wilson, pers. comm.). To verify that *L. adonis* had laid the eggs in the 'nest', seven eggs were taken from the edges and centre of the egg cache and incubated at room temperature in moist vermiculite.

The eggs varied in length from 9.54mm to 10.76mm (n=7, mean=9.91), in width from 7.07mm to 7.94mm (n=7, mean=7.61) and weighed between 0.30g and 0.38g (n=7, mean=0.33). They hatched over a 24 hour period on 25th (4 eggs) - 26th (3 eggs) January, 1995. All seven hatchlings were identified as *L. adonis*. As the eggs were collected widely

across the nest and hatched over a short time frame, it is reasonable to assume that the entire egg cache was deposited by *L. adonis*, and that the eggs had been laid more or less simultaneously. The maximum clutch size recorded for *Lampropholis* (*L. delicata*) is seven eggs (Greer, 1989: Table 9). Presuming *L. adonis* produces similar sized clutches to *L. delicata*, a cache of 53 eggs would represent the nesting effort of at least eight females.

The hatchlings (QMJ59313-59315, QMJ59331-59334) measured 17.12mm to 20.36mm SVL (n=7, mean = 18.86) and had a total length of 39.47mm to 43.18mm (n=7, mean = 41.57). They weighed (preserved weight) between 0.17g and 0.20g (n=7, mean=0.18). All hatchlings were similarly marked to adults of this species (Ingram, 1991).

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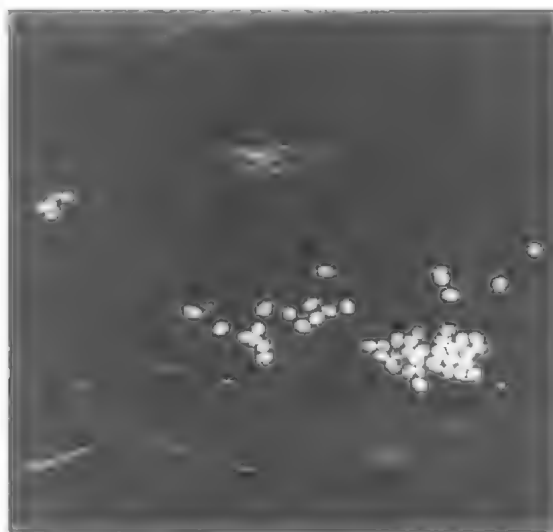


FIG. 1. A communal nest containing 53 *L. adonis* eggs, Bulburin SF.

A NEW ISCHNACANTHID ACANTHODIAN FROM THE LATE SILURIAN
(LUDLOW, *PLEECKENSIS* ZONE) JACK FORMATION,
NORTH QUEENSLAND

C.J. BURROW & A.J. SIMPSON

Burrow, C.J. & Simpson, A.J. 1995 12 01: A new ischnacanthid acanthodian from the Late Silurian (Ludlow, *pleeckensis* Zone) Jack Formation, north Queensland *Memoirs of the Queensland Museum* 38(2) 383-395. Brisbane. ISSN 0079-8835.

Scales, fin spine fragments, two symphyseal tooth whorls, a dentigerous jaw bone fragment, and dentition cones of a new acanthodian species comprise the total acanthodian component from samples of the Jack Formation. The morphological variety of scales includes three normal body scale types, two specialized head scale types, pore scales and tesserac. The range of scale types, the shape of the fin spine fragments, and the form of the dental elements, indicate they are from a new species of ischnacanthid acanthodian. □ *Acanthodiu*, *Jack Formation*, *Gomphonchus*, *ischnacanthid*, *Ludlow*, *microvertebrates*, *scales*.

C.J. Burrow, Department of Zoology, University of Queensland, Australia 4072; A.J. Simpson, Geology Museum, University of Queensland 4072, Australia; 1 October 1995.

Acanthodian scales are common in microvertebrate assemblages from Upper Silurian and Devonian limestones throughout Australia, but until recently there have been no systematic descriptions of them. Burrow (1995a) described several new taxa from the late Lochkovian/early Pragian Connemarra Formation and Gleninga Formation (including the Jerula Limestone Member) of central New South Wales. Turner & Pickett (1982) were the first to report Acanthodian scales from the Silurian of Australia. Turner (1991, 1993) recorded various occurrences of Acanthodian remains from Silurian deposits in eastern Australia, including material described in this paper. The present paper describes the microvertebrate assemblage in an acetic acid-treated samples from the Jack Formation of northern Queensland. The acanthodian component appears to derive from a single species. The only other vertebrate element in the section is a scale of the primitive osteichthyan *Lophosteus* cf. *L. superbus*, the type material of which is from Pridoli deposits in the Baltic. Material is lodged in the Geology Museum, University of Queensland (UQY).

STRATIGRAPHY

Vertebrate remains were recovered from samples processed to extract conodonts from the Jack Formation (Simpson, 1983, 1994b), the uppermost unit of the Graveyard Creek Group, Broken River Province, north Queensland (Fig. 1). The Group consists of the predominately siliciclastic Crooked Creek Conglomerate, Quinton Forma-

tion and Poley Cow Formation, and siliciclastics and carbonates of the Jack Formation.

The Jack Formation, originally the Jack Limestone Member of the Graveyard Creek Formation (White, 1959), previously included only carbonate lithologies exposed in the area around the Broken River where it is cut through by the Jack Hills Gorge. Remapping of the area by the Geological Survey of Queensland raised the unit to formation-status (Withnall, 1989) and broadened its concept to incorporate siliciclastic rocks, interpreted as lateral equivalents of the carbonates in areas to the north and south (Withnall et al., 1993). Recent work (Sloan et al., 1995) has shown that some of these lateral equivalents may represent allochthonous deposits post-dating some autochthonous outcrop tracts of the Jack Formation.

The Jack Formation conformably overlies and interfingers with the Poley Cow Formation (Fleming, 1986; Withnall & Fleming in Withnall et al., 1993). It is disconformably overlain by siliciclastics of the Early Devonian Shield Creek Formation.

Specimens described here are from sections along Bullock Creek through the western limb of an unnamed, southwesterly plunging syncline, located 0.5 km to the south west where the Pandanus to Wandovale road crosses the Broken River, east of the axis of the Broken River Anticline (Withnall & Lang, 1992). The core of this syncline consists of two distinct lithologies of the Jack Formation. This region was mapped as undifferentiated Jack Formation by Withnall & Lang (1992). Brief notes on the lithology are

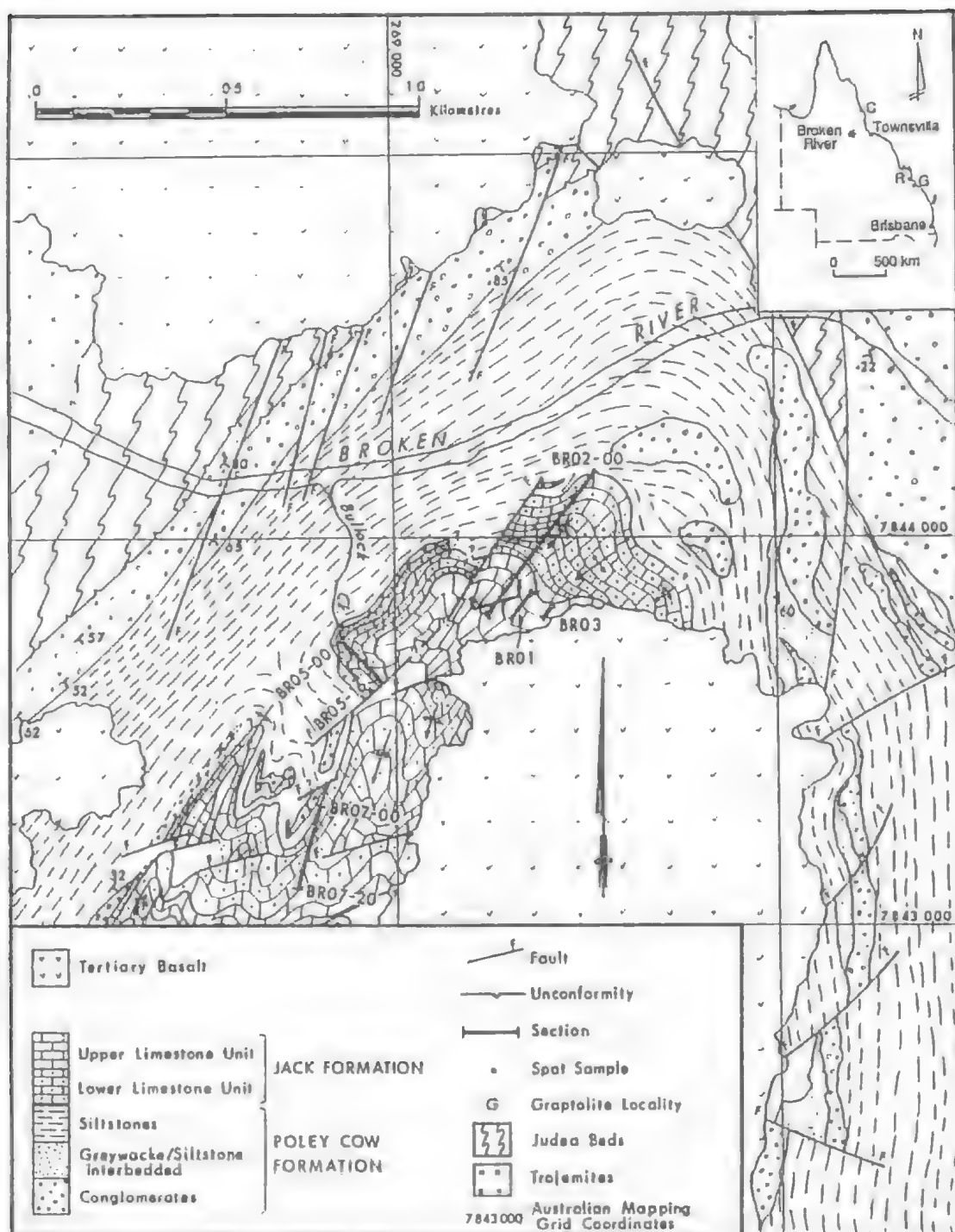


FIG. 1. Map of syncline near Broken River crossing showing location of sections through the Jack Formation, north Queensland. Acanthodian remains are from Section BR07 (Upper Bullock Creek Section), in near basal samples BR07-01 and BR07-02.

given below, as the sequence in the syncline differs from the type section 4km to the west, in the Jack Hills Gorge (Withnall & Fleming in Withnall et al., 1993).

In the syncline, the lower part of the Formation consists of thin-bedded siltstone and fine-grained, micaceous arenite interbedded with a range of carbonate lithologies, many with abundant corals in growth positions; a highly variable sequence colloquially known as the "coral gardens" (lower limestone unit, Fig. 1). The basal sequence of the "coral gardens" unit has, in places, discontinuous, lenticular beds of calcirudite, which crop-out sporadically around the nose of the syncline. One of these has been interpreted as a massive debris flow, possibly part of a channel cutting through autochthonous carbonates and clastics of the coral gardens unit (Sloan et al., 1995: 52). As well as conodonts of the *ploeckensis* and *siluricus* Zones, and acanthodian material, carbonates of the coral gardens unit have also yielded foraminifera, algae, sponge spicules, byronids and phyllocarid remains (Simpson, 1994).

The "coral gardens" unit at the Broken River crossing is overlain by a massive- to thinly-bedded upper limestone unit (Fig. 1). Thicker to massive beds consist of fine-grained muddy and dolomitic limestone containing minor corals and stromatoporoids. Thinner beds consist of a variety of lithologies, including beds of richly bioclastic detritus. These may consist of a range of skeletal allochems or may be dominated by a single allochem. Dominant allochems include large articulated crinoid stems, some with oncolitic envelopes, large, low-spined gastropods, and abundant brachiopods. The upper limestone unit has yielded the conodont *Icriodus woschmidtii hesperius* Klapper & Murphy some 45m above the base, indicating the approximate position of the Silurian-Devonian boundary. A broad study of the Jack Formation (Simpson, 1995) shows that it extends into the Devonian only in this area. In all other regions including the type section the uppermost beds of the formation all terminate within the Silurian.

A review of biostratigraphic data pertaining to all the constituent units of the Graveyard Creek Group has been recently presented (Jell, et al., in Withnall et al., 1993).

Samples yielding acanthodian remains were all restricted to the "coral gardens" unit of the Jack Formation from the Upper Bullock Creek section (Simpson, in press). Acanthodian elements were most abundant in samples BR07-01 and BR07-02, some 7m and 10m stratigraphically above the

base of the Jack Formation, but were also recovered much higher in the section, just below the first appearance of *Polygnathoides siluricus*. The age of these samples is discussed separately below.

AGE OF THE SAMPLES

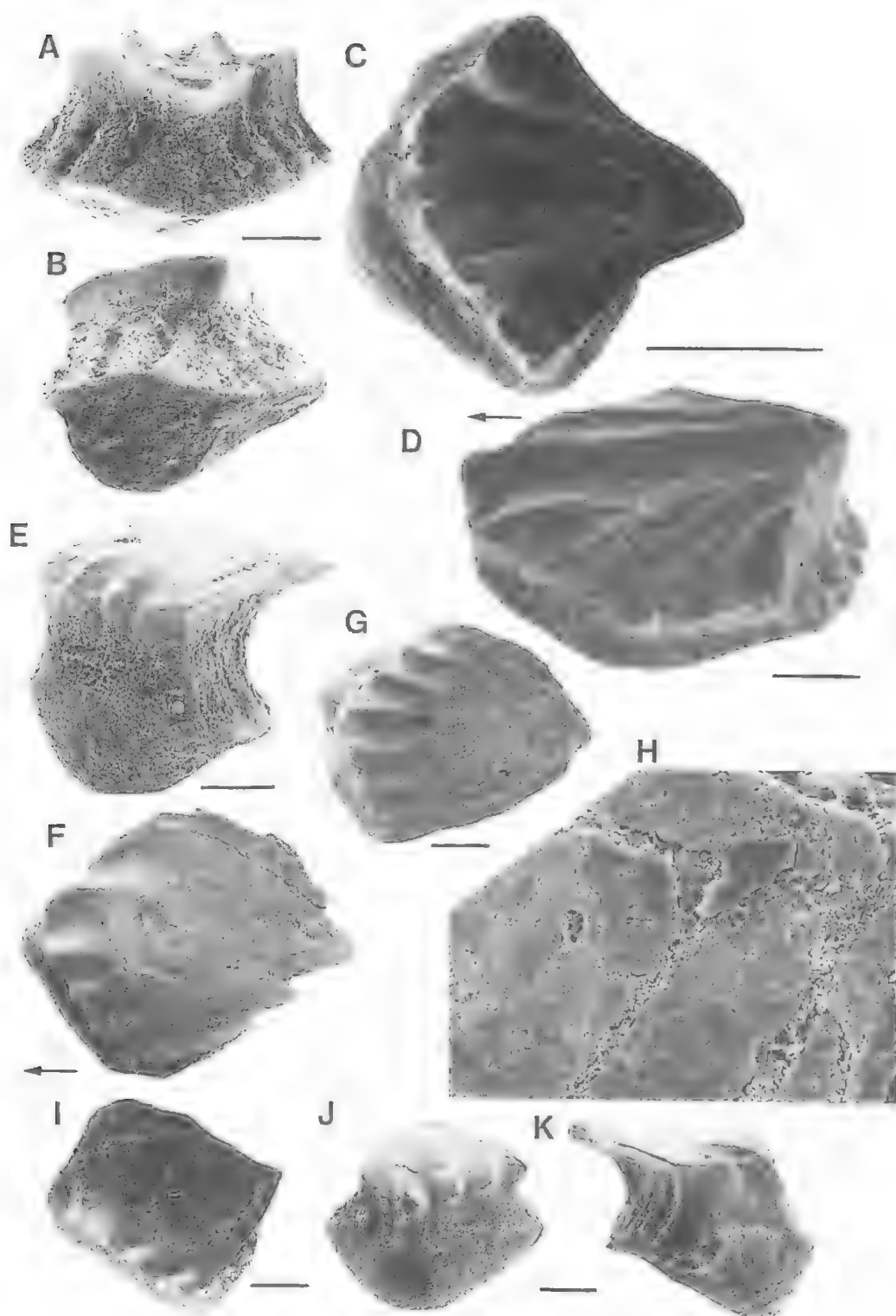
Basal samples of the Upper Bullock Creek section through the "coral gardens" unit of the Jack Formation yield the Ludlow zonal index conodont *Ancoradella ploeckensis* (Walliser, 1964). The species ranges through the lower 95m of section equalling approximately the lower 75% thickness of the "coral gardens" unit (Simpson, in press). The succeeding Ludlow zonal index, *P. siluricus* occurs in small numbers over a narrow stratigraphic range in the upper part of the range of *A. ploeckensis*. The stratigraphic overlap of these two species is well established and has been discussed by a number of authors (Klapper & Murphy, 1975; Simpson & Talent, 1995) and has been recorded previously in Australia (Link & Druce, 1972).

Although recent work (Simpson & Talent, 1995) has shown that *A. ploeckensis* probably extends back into the late Wenlock, there is no evidence to suggest that basal samples of the Jack Formation (in section BR07) are any older than Ludlow. The associated conodont fauna is typically Ludlow in aspect. Furthermore, morphometric analysis of Pa elements of *A. ploeckensis* (Simpson, 1994a; Simpson & Talent, 1995) suggest Ludlow rather than late Wenlock examples.

As noted above, acanthodian specimens documented here were all recovered from strata predating the appearance of *P. siluricus*, hence permitting a fairly narrow age diagnosis for the vertebrate fauna.

The *siluricus* Zone is generally equated with the basal Ludfordian *leintwardinensis* graptolite Zone (Cocks & Nowlan, 1993). Jeppsson (1983) discussed the age of *P. siluricus* and concluded it was late? Leintwardinian or late? early Ludfordian. Other authors give a slightly older range-base for the taxon: Kleffner (1989; fig. 6) indicated a latest Gorstian age for the first appearance of the species.

As the Jack Formation Acanthodian specimens were all recovered from strata of the *ploeckensis* Zone pre-dating the *siluricus* Zone, from a section where there are no obvious stratigraphic or chronological discontinuities, the age range of the fauna can be considered, on available data, to extend from the early to middle Ludlow (Gorst-



ian), with youngest examples being probably no younger than latest Gorstian in age.

Although Australian data indicate a Gorstian age, a single element was recovered from the Lorentz River, Irian Jaya (Turner et al., 1995; fig. 5J). This locality produced a late Ludlow *crispa* Zone conodont fauna (Van den Boogaard, 1990), indicating species range throughout the Ludlow.

SYSTEMATIC PALAEOONTOLOGY

Class ACANTHODII Berg, 1922
Order ISCHNACANTHIDA Berg, 1940
Family ISCHNACANTHIDAE Woodward, 1891

Gomphonchus Gross 1971

TYPE SPECIES

Gomphonchus sandelensis (Pander) 1856.

DIAGNOSIS (after Denison, 1979: 39)

Scales with a low or convex base, low or elevated crown that may be smooth or ornamented with radiating ribs. Base is cellular bone, rarely penetrated by fine canals from the inner surface. The crown is dentinous with thin layers of enameloid on top, without a well developed canal system, but with long dentine tubules that rise in the neck and turn toward the centre of the crown top, giving off side branches. Stellate platelets from the head have apposed rather than superposed growth zones. Tooth spirals carry teeth with a large cusp and small side cusps. Fin spines are slender, nearly straight, and usually ornamented with smooth, longitudinal ribs of which the anterior rib is largest. Spines are composed entirely of dentine except for a thin basal layer of bone.

Gomphonchus? turnerae sp. nov. (Figs 2-6)

1982 'Vertebrate fragments' Turner & Pickett: 314.

1991 'Scales, spines, jaws and, tooth whorls of Acanthodians' Turner: 446-7.

1993 Scales of *Nostolepis* and *Gomphonchus* Turner: 179.

?1995 'Acanthodii indet.' Turner et al.: fig. 5J.

DIAGNOSIS

An ischnacanthid acanthodian with a range of scale types comprising: small, 'normal' body scales with two to six sharp, longitudinal crown ribs and a median longitudinal furrow; typical ischnacanthid head scales with a broad, flat, irregularly shaped base, and apposed growth zones in the crown, and also special head scales with a long crown bearing a jagged, irregular ornament; pore scales with four to seven short, anterior crown ribs, of about four pore canal openings under the posterior crown, and up to 10 pores on the posterior crown surface; symphyseal tooth whorl with four or five teeth comprising from one to five cusps, which bear longitudinal, branching, noded ridges.

MATERIAL EXAMINED

HOLOTYPE: body scale morphotype I, UQY7692 (Fig. 2C): lower part of the Jack Formation, Graveyard Creek Group, Ludlow, *ploekensis* Zone, exposed in Bullock Creek, on the western flank of the unnamed syncline 1 km southwest of the Broken River crossing on the Wandovale-Pandanus Creek road.

PARATYPES: body scale morphotype II, UQY7693 (Fig. 2D); body scale, morphotype III, UQY7694 (Fig. 2E,F); head scale, morphotype IV, UQY7695 (Fig. 4A,B); head/sensory line scale, morphotype V, UQY7696 (Fig. 4C,D); symphyseal tooth whorl, UQY7697 (Fig. 6A).

OTHER MATERIAL: 303 scales, two tesserae, seven dentition cones (including UQY7698, Fig. 6E), one small dentigerous jaw bone fragment UQY7699 (Fig. 6D), two fin spine fragments (including UQY7715, Fig. 7A), and ground thin sections UQY7701-5 (Figs 3A-D, 7B,C, in order), from samples BR07-01 and BR07-02, Upper Bullock Creek section, Jack Formation.

ETYMOLOGY

In recognition of Dr Susan Turner's contribution to IGCP 328: Palaeozoic Microvertebrates.

FIG. 2. Normal body scale types of *G.? turnerae* sp. nov. from sample BR07-02, Jack Formation, north Queensland. A,B. Morphotype I scale, UQY7707 in anterior view (A), and latero-basal view (B). C. Crown view of morphotype I scale, holotype UQY7692. D. Paratype scale, morphotype II, UQY7693, latero-crown view. E,F. Paratype scale, morphotype III, UQY7694, in lateral view (E), and crown view (F). G,H. morphotype III scale, UQY7708, in crown view (G), and close-up of posterior section of scale (H). I,J. Asymmetrical scale, morphotype III, UQY7709, in crown view (I), and anterior view (J). K. morphotype III scale, UQY 7710, lateral view. Arrow points in a rostral direction; scale bar = 0.1 mm.

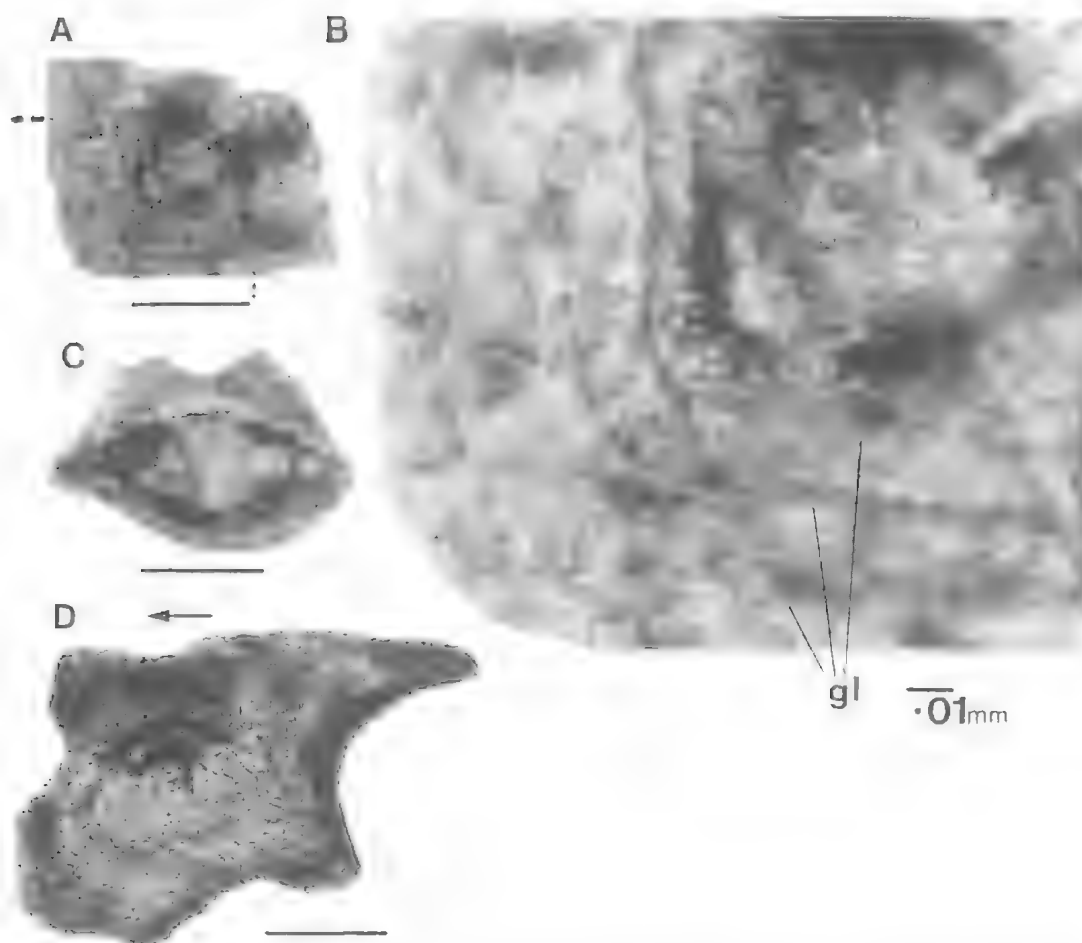


FIG. 3. Ground thin sections of scales of *G.? turnerae* sp. nov. from the sample BR07-02, Jack Formation. A,B, Horizontal section of crown, morphotype I scale, UQY7701; (B) is a magnified area of (A). C, Vertical transverse section of morphotype I scale, UQY7702. D, Vertical longitudinal section of morphotype III scale, UQY7703. Arrow points in rostral direction; scale bar = 0.1 mm unless stated.

DISTRIBUTION

Jack Formation, Broken River Province, northern Queensland (Ludlow, *ploeckensis* Zone); undifferentiated Palaeozoic rocks, Lorentz River, east Irian Jaya (late Ludlow, *crispa* Zone).

DESCRIPTION

Body scales, morphotype I (Figs 2A-C, 3A-C) range from 0.1 to 0.4 mm wide, and 0.1 to 0.4 mm long; most scales are towards the lower size limit. They are bilaterally symmetrical, with a sub-rhombic, horizontal crown, which has a sharply marked anterior edge (Fig. 2C). Two high, strongly developed, sub-parallel ridges lead back

from the anterior edge, decreasing in height towards the posterior crown edge (Fig. 2A,C). These ridges enclose a rounded, central furrow, and are flanked by relatively flat, lateral areas. Crown width and length are usually slightly less than those of the base, though the posterior crown point extends slightly beyond the base on some scales (Fig. 2C). The neck slopes away from the crown on all sides, and may have a buttressed appearance from the vertical slits, which indicate the position of canal openings on the latero-posterior neck area (Fig. 2A,B). The neck/base junction is a well-marked rim, with a lemon-shaped outline. The base has a typically 'gomphonchid'

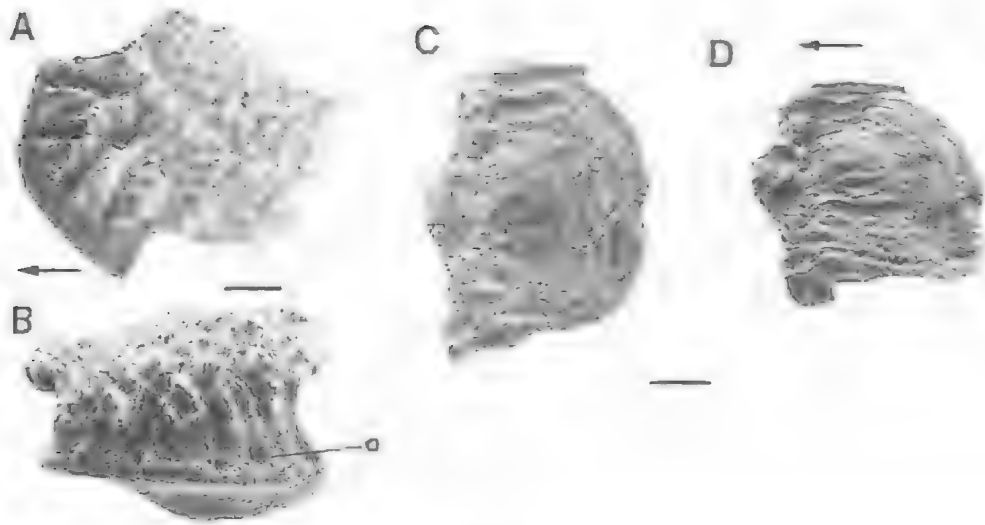


FIG. 4. Head scales of *G. ? turnerae* sp. nov. from sample BR07-02, Jack Formation. A, B, paratype head scale, morphotype IV. UQY7695. A, in crown view. B, anterior view. C, D, paratype head/sensory line scale, morphotype V. UQY7696. C, crown view. D, latero-crown view. Arrow points in a rostral direction; scale bar = 0.1 mm; o = vascular canal opening.

shape, being moderately vaulted, with the swelling pushed forwards, and flattening out, or becoming slightly concave, towards the posterior rim (Fig. 2B).

Fungal hyphae and remineralization have obscured much of the histological detail of the scales; however, some details of the pattern of dentine tubules, and the structure of the base, are discernible (Fig. 3A-C). No bone cell lacunae are preserved in the base or the crown; nor are there any wide vascular canals. Small patches of dentine that are preserved (Fig. 3A, B) comprise networks of tubules without lacunae. The Sharpey's fibres of the base form a simple cone, radiating from the base apex (Fig. 3C); the bone lamellae of the base are highlighted by the interruption of the remineralized fibres.

Body scales, morphotype II (Fig. 2D) have a similar size range to morphotype I scales, and also have the distinctive central crown furrow, but differ in being more vertically compressed, and in the ornamentation of the lateral crown zones. The latter areas have several somewhat sinuous ridges leading up and back from the anterior or lateral crown edge, directed towards the central ridges (Fig. 2D). The neck is short, and the base is only slightly vaulted.

Body scales, morphotype III (Figs 2E-K, 3D) are slightly larger than those of morphotypes I and II, being 0.4 to 0.6 mm wide. Their crowns

usually have the same central furrow, however the ridges lining it are usually shorter and lower than on morphotype I and II scales. The anterior crown bears two to four additional short ribs (Fig. 2E, G, K). Many of the scales of this type exhibit 'cracks' delineating the growth lines of the posterior crown, but no discrete pore canal openings are visible (Fig. 2H). The posterior crown edge is denticulated on some scales, and overhangs the base (Fig. 2F). The posterior neck area is deeper than on morphotype I scales, and is marked by the same vertical slits (Fig. 2K). The anterior neck area has small, regularly spaced, circular pore openings (Fig. 2K). As on morphotype I scales, the base swelling is pushed forwards (Fig. 2E, K).

Head scales, morphotype IV (Figs 4A, B, 5C, D) are 0.3 to 0.4 mm wide, and up to 0.6 mm long. Some less abraded scales of this type have a micro-ornament of noded ridges (Fig. 5C, D). The crown is approximately horizontal, and its apposed growth yields an upper surface comprising a jagged, irregular ornament, which merges into the neck anteriorly (Fig. 4B). The crown is up to three times as long as the base. Small, regularly spaced, circular canal openings pierce the short, anterior neck (Fig. 4B). The base is very low or flat, and is wider than long.

Head/sensory line scales, morphotype V (Fig. 4C, D) c. 0.6 mm wide and 0.5 mm long. Along the relatively straight anterior edge, the crown rises

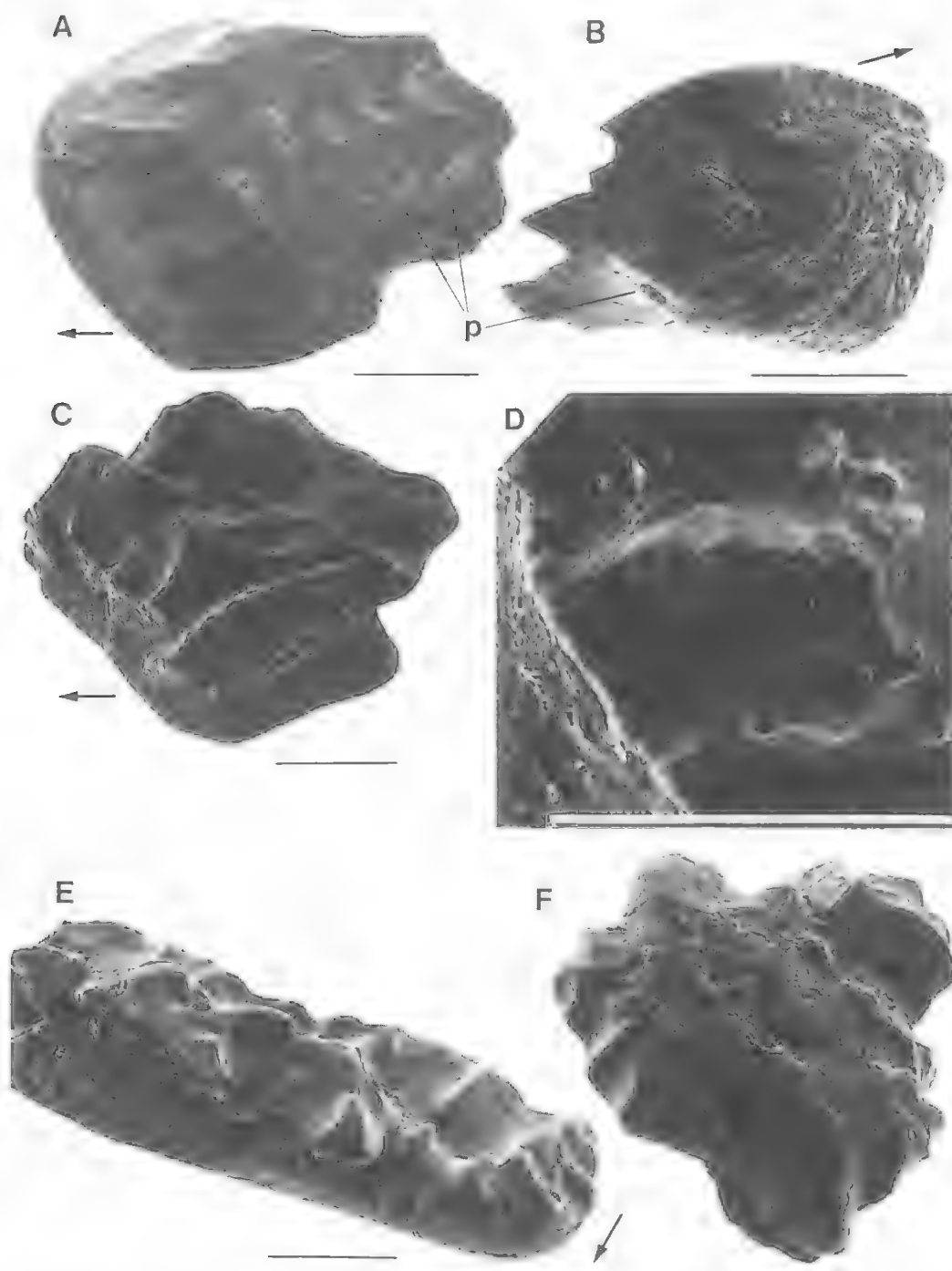


FIG. 5. Special scales of *G.? turnerae* sp. nov. from BR07-02, Jack Formation. A, crown view, morphotype VI scale, with pore canal openings in posterior crown, UQY7711. B, latero-basal view, morphotype VI scale, UQY7712. C,D, small head scale, morphotype IV, UQY7713. C, latero-crown view. D, close-up view, showing nodose micro-ornament. E, anterior view of short, wide scale, UQY7714. F, crown view, tessera, UQY7700. Scale bar = 0.1mm.

up sharply from the base, then curves backwards, so that the rest of the crown slopes up only slightly towards the posterior (Fig. 4D). The crown exhibits areal, rather than superpositional, growth zones, marked by ridges running parallel to the semi-circular outer crown edge (Fig. 4C,D). No pore canal openings are detectable on the main crown surface. The crown is much longer than the base, which is two to three times wider than long, and flat or with a shallow vault.

Pore scales, morphotype VI (Fig. 5A,B). A small number of scales (c. 2%) have several large pore canal openings under the posterior crown, and up to 10 (or possibly more) pores on the posterior crown surface (Fig. 5A). The scales are 0.4 to 0.5 mm long, and 0.2 to 0.3 mm wide. Short, rounded, sub-parallel ridges adorn the anterior crown, rarely extending to the posterior half of the crown surface. The posterior crown overhangs the base (Fig. 5B). Depth of the neck can vary markedly, being negligible below the anterior crown edge on some scales (e.g., Fig. 5A), and quite deep on others. The base/neck junction does not form a sharp rim; the bases of most of these scales lack the typical 'gomphonchid' shape of the other morphotypes. Instead, the base is relatively symmetrical, with a rounded, lumpy surface (Fig. 5B).

Several small tesserae (Fig. 5F) of 'gomphonchid' type *sensu* Gross, 1971 (pl. 2, fig. 27) were in the assemblage, and are also presumed to belong to *G. ? turneræ* sp. nov.

The two symphyseal tooth whorls (Fig. 6A-C) found in the sample have a base that arches from anterior to posterior, and are about 0.6 mm long. The whorls bear four (UQY7697) and five teeth (UQY7706) respectively (Fig. 6A,B), increasing in size from anterior to posterior. A small, single-cusped tooth is foremost on whorl UQY7706, and the following teeth are all three-cusped, with the central cusps larger than the side cusps. The central cusp (with a broken tip) of the posterior, largest tooth of whorl UQY7706 (Fig. 6B,C) is 0.5 mm high, with side cusps 0.15 mm high. All cusps bear longitudinal ridges; the noded, branching ridges of UQY7697 are particularly well preserved (Fig. 6A).

Seven dentition cones (Fig. 6E) have the same form as some of those of *Poracanthodes menneri* described and figured by Valiukevicius (1992; pl. 2, figs 2,3, pl. 3, fig. 2): namely, an elongated, hollow cone, with a row of denticulations and/or randomly positioned denticles. Burrow (in press, b) characterised these elements, from Lochkov-

ian microvertebrate assemblages of central New South Wales, as dentition cones type I and II.

One small dentigerous fragment (UQY7699 Fig. 6D) of the anterior section of a jaw bone was preserved. The base has the latero-medial concavity characteristic of acanthodian jaw bones, marking the position of the jaw cartilage (Fig. 6D). The occlusal surface has a medial ridge, and a higher lateral ridge, separated by a shallow groove. Only one cusp is preserved, on the broken posterior extremity of the fragment.

Several small fin spine fragments (Fig. 7A-C) up to 2 mm long were in the assemblage; some of these were sectioned (Fig. 7B,C). The spines are ornamented with relatively smooth and rounded, parallel, longitudinal ribs. The anterior rib, forming the leading edge of the spine, is widest, followed by three ribs each about 0.1 mm wide. All ribs are separated by rounded grooves of equal width. A wider groove separates these ribs from the posterior area of the spine, which varies in width depending on the age of the spine.

REMARKS

The material described comprises the sum of the determinable acanthodian elements in the sample, and by comparison with the range of elements in articulated specimens of *Poracanthodes menneri* Valiukevicius, 1992, is interpreted as belonging to a single species. Gross (1971), in attributing scales, tooth whorls, dentigerous jaw bones, and fin spines to *Gomphonchus sandelensis*, and *Gomphonchus* sp., considered that *Poracanthodes* (Brotzen, 1934) was not an independent genus, and believed poracanthodid scales to be modified lateral line scales of *G. sandelensis* and *G. hoppei*. Whereas *Poracanthodes* is now recognized as a valid genus, no articulated specimens of *Gomphonchus* have yet been found. As Gross did not attribute any dental elements or fin spines to *Poracanthodes*, it is probable that some of the elements he assigned to *Gomphonchus* are referable to *Poracanthodes* (see Burrow, in press, b, for further discussion of this topic).

Unfortunately, remineralization and fungal hyphae have obscured histological detail of the Jack Formation scales, precluding a firm generic classification based on the scales alone. Morphologically, the posterior crown section of morphotype III scales appear to show areal rather than superpositional growth (Fig. 2F-H), as in scales of *Poracanthodes menneri*. Pore canal networks are not detected, however, in ground thin sections of *G. ? turneræ* sp. nov. scales. The growth zone

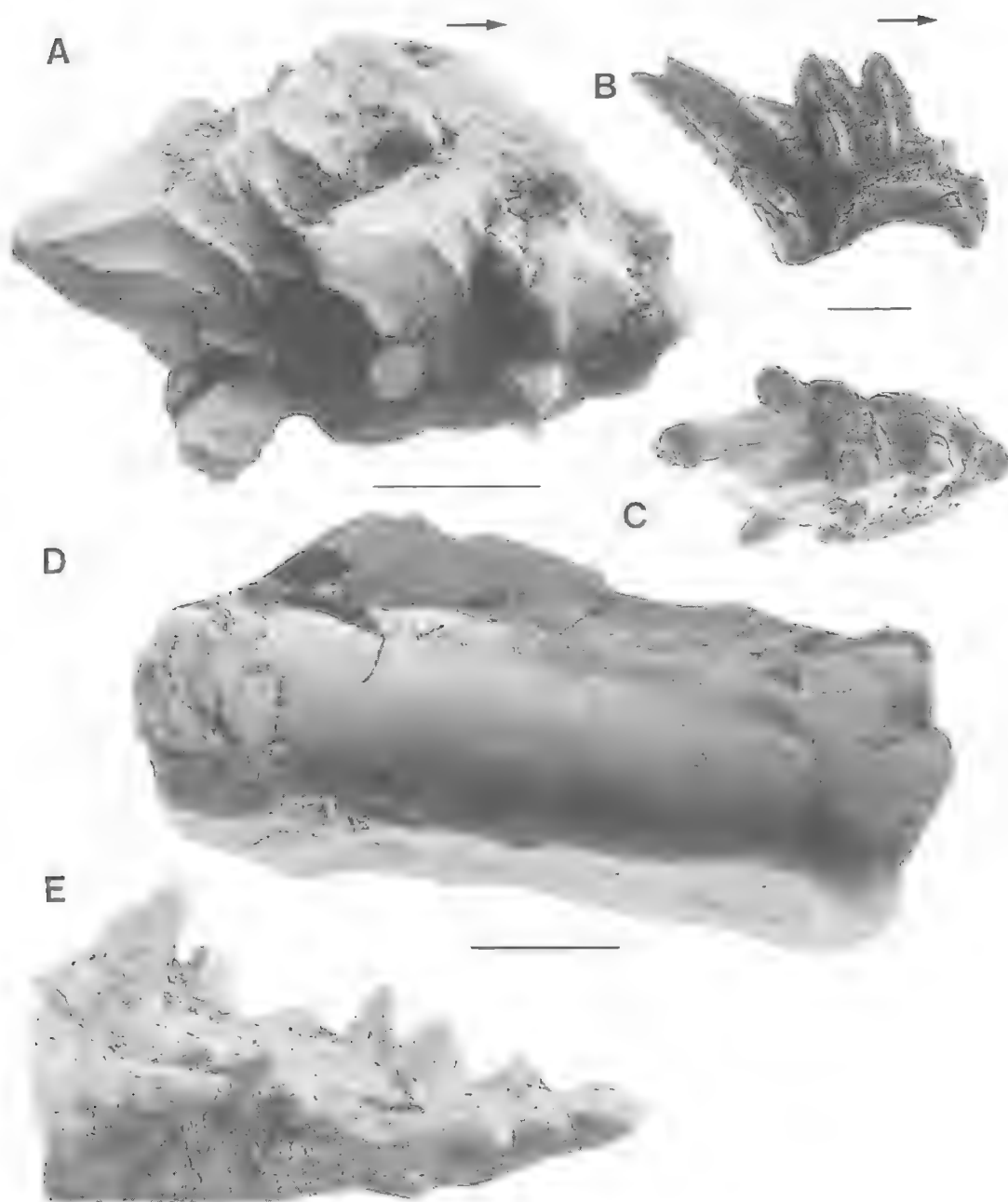


FIG. 6. Symphysial tooth whorls, dentigerous jaw bone fragment, and dentition cone of *G.? turnerae* sp. nov., from the Jack Formation. A-D are from sample BR07-02, E is from BR07-01. A, occlusal view of paratype tooth whorl, UQY7697, with branching, noded ridges. B,C, tooth whorl UQY7706. B, in lateral view. C, occlusal view. D, concave base of dentigerous jaw bone fragment UQY7699. E, lateral view, dentition cone UQY7698. Arrow points in a rostral direction. Scale bar = 0.2mm.

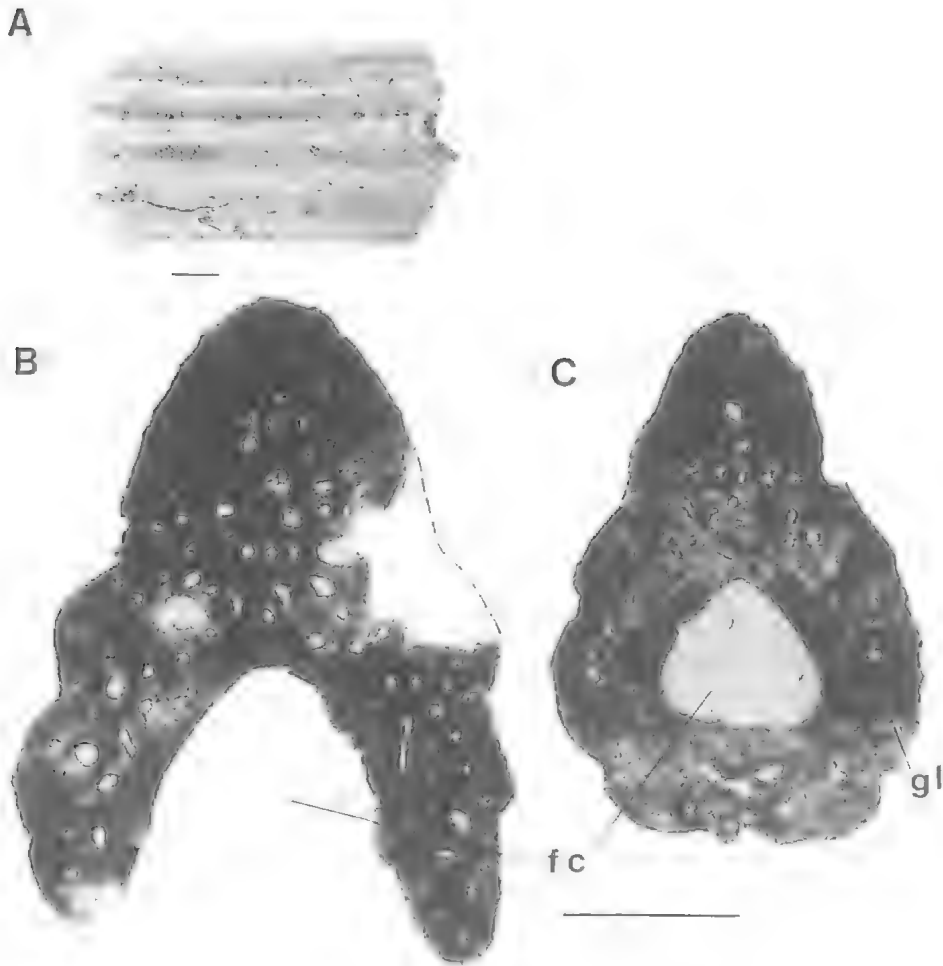


FIG. 7. Fin spine fragments of *G.?* *turnerae* sp. nov., from BR07-02, Jack Formation. A, lateral view, UQY7715. B, cross-section of a juvenile fin spine, with open cavity, UQY7704. C, Cross-section of fin spine with two growth zones, UQY7705. fc = longitudinal fin spine cavity, gl = growth line delimiting first growth zone. Scale bar = 0.2 mm.

'cracks' on these scales are probably an artifact of preservation, caused by the thinness of the growth zones in the posterior crown, abrasion, and fungal invasion. This theory is enhanced by the lack of pore canal openings on the crown of morphotype V head scales, as comparable scales on *P. menneri* have many such openings (Valiukevicius, 1992; pl. 9, fig. 6a,b). Morphotype V head/sensory line scales are commonly found in microvertebrate assemblages (e.g., Burrow, in press, a; pl. 3, fig. 14; and possibly Mader, 1985; pl. 3, fig. 2), and are similar to the sensory line scales on the head of *Ischnacanthus gracilis*,

in Miles (1966; fig. 11) and Bernacsek & Dineley (1977; pl. 6, fig. 4). Morphotype IV head scales appear the same as the special head scales of *P. menneri* (Valiukevicius, 1992; pl. 9, figs 2-4). Only the poorly represented morphotype VI scales assigned to *G.?* *turnerae* have the pore canal openings on the underside of the posterior crown, which are typical of *Poracanthodes* scales.

The symphysial tooth whorls (Fig. 6A-C) resemble those attributed to "*Gomphodus*" *sandelensis* by Gross (1957; fig. 1), and differ from the lone, small, tri-cusped whorl assigned to

P. menneri (Valiukevicius, 1992; figs. 5a,b). However, the latter whorl was broken, and the number of teeth per whorl is probably variable, as illustrated by Gross (1957; figs 1,2) for "*Gomphodus*" *sandelensis*. The *G. ? turnerae* whorls differ to all previously described examples by their distinctive, branching, longitudinal ridges (Fig. 6A); this ornament gives the cusps a 'tubercular' appearance.

The *G. ? turnerae* fin spine fragments (e.g., Fig. 7A) resemble those of *P. menneri* (e.g. Valiukevicius, 1992; text fig. 11B). Fin spines of the ischnacanthids *Ischnacanthus gracilis*, *P. menneri*, and *Gomphonchus* sp., conform to a common pattern of smooth, longitudinal ribs, with the leading rib wider than the following ribs. The number of the narrower ribs varies with the age of fish, and the position of the spine on the body (Valiukevicius, 1992; 205). Gross (1971; figs 24E,F, 25A,C,D,E, 26A) illustrated cross-sections of young and old spines, showing the increasing number of growth zones corresponding to the age of the spine, which leads to the variation in their external morphology. Fin spine ornamentation, thus, is as yet of limited use in assigning fin spines to any of these ischnacanthid genera.

A comparable suite of acanthodian elements, incorporating all elements listed for *G. ? turnerae* except the morphotype IV scales, was observed in microvertebrate assemblages from several sites in the Lower Devonian Trundle beds of central New South Wales (Burrow, in press, a, b). This particular range of elements was tentatively attributed to a new taxon. Only a small percentage of the Trundle beds scales of this taxon had pore canal openings on the upper surface of the crown, just as in the *G. ? turnerae* sample. Determining if the new ischnacanthid should be assigned to *Poracanthodes*, or *Gomphonchus*, or a new genus, is difficult without scales which have been well preserved histologically. Primarily on the basis of the lack of a discernible pore canal system, and the apparent absence of bone cell lacunae in the base, they are assigned to *Gomphonchus*? rather than *Poracanthodes* because of the lack of good histological detail, they are not assigned to a new genus. A scale figured by Turner et al. (1995; fig. 5J) from an erratic block of the Lorentz River, east Irian Jaya (late Ludlow age), appears to be a morphotype III scale of *G. turnerae*. *Gomphonchus ? turnerae* is the oldest acanthodian described from Australian assemblages.

ACKNOWLEDGEMENTS

We thank Dr Susan Turner (Queensland Museum) for her initial investigations of the material, and for critical appraisal of the manuscript; and Dr John Long (Western Australian Museum) for SEM photography and ground thin sections of some of the material. Specimens were recovered during an honours project undertaken by one of us (AJS) at Macquarie University. Ruth Mawson and John Talent (Macquarie University) are thanked for the use of facilities, encouragement and discussion on stratigraphy. John Jell (University of Queensland) is thanked for his field expertise and imparting his knowledge of the stratigraphy of the region. Fig. 1 was drafted by Joanne Simpson with customary skill. This is a contribution to IGCP328: Palaeozoic Microvertebrates.

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SAP FEEDING BY THE AUSTRALIAN GECKO *GEHYRA DUBIA*. *Memoirs of the Queensland Museum* 38(2):396. 1995:- Although Australian geckos are generally opportunistic arthropod feeders (Greer, 1989), several species will also feed on plant nectar and sap. *Christinus guentheri* and *Rhacodactylus lindneri* lick nectar from blossoms (Cogger et al., 1983; King & Horner, 1993). *Gehyra australis* licks decaying, or pulpy fruit (King & Horner, 1993); and *Christinus marmoratus*, *Heteronotia binoei* and *Lepidodactylus lugubris* will feed in captivity on sugar-based substances (after Greer, 1989). Only two records of geckos feeding on sap are known. *Gehyra variegata* feeds on the sap of small *Acacia* shrubs in Western Australia (Dell, 1985); *Strophurus spinigerus* was seen by one of us (SKW) feeding on *Acacia* sap near Perth, WA, in spring, 1981.

On 21 March, 1995, in open forest 15 km south of Yuleba (26°43'26"S, 149°19'E) SEQ, a specimen of *Gehyra dubia* was observed at approximately 1930h head-down, apparently licking sap from the trunk of a small tree, *Acacia leiocalyx leiocalyx*. Small black ants were present, so it was difficult to determine whether the gecko was feeding on these or the *Acacia* sap.

Later in the evening 2040h 1 km south of the initial observation site, several specimens of *G. dubia* (2-3 per tree) were seen near the bases of trunks of small *Acacia* trees. Six specimens were feeding on sap. Two were observed for 18 minutes. The first was feeding 15 cm above the ground, on a 2.7 metre high *Acacia l. leiocalyx* tree with a trunk diameter of 5 cm. The gecko was head-down, licking at a 1 cm 'bead' of sap on which a solid crust had formed. The gecko's tongue penetrated this outer crust to extract the softer, almost liquid, sap. The second gecko was feeding in the same way, also on sap of an *A. l. leiocalyx* tree (3 m high, trunk diameter 8 cm). The gecko was about 11 cm from the ground, and was licking a 2 cm weeping 'wound' on the *Acacia* trunk. Both geckos were collected (QMJ59560-61), killed and preserved immediately. The full duration of this behaviour was not recorded. At this site, geckos were also feeding on sap from trees of two other species - *A. conferta* and *A. decora*. Similar behaviour by *G. dubia* was observed in Barakula State Forest (26°15'S, 150°30'E) in December, 1982 (SKW), on an unidentified *Acacia* tree.

Both QMJ59560-61 are adult males, with enlarged testes. They have full stomachs. That of QMJ59560 (SVL 63.0 mm) contains fragments of a large katydid (Tettigoniidae). The

stomach of QMJ59561 (SVL 64.7 mm) contains earwig and cockroach fragments. No recognisable *Acacia* sap is present. There are two possible explanations for the apparent absence of sap from both stomach contents: relatively small amounts of it were ingested; it is likely that sugary fluids are rapidly and completely digestible. The presence of insect remains in both gut samples shows that arthropods remain an important food source for *G. dubia* specimens, even when they feed on sap.

Sap-feeding by *Gehyra* cf. *baliola* and *Rhacodactylus australis* has been observed (SKW) recently. a specimen of the former was photographed (QMNP754) feeding on the sap of an *Acacia* sp. tree, 500 m from the tip of Cape York Peninsula (10°41'S, 142°33'E). The *R. australis* was seen feeding on the sap of an unidentified rainforest tree in the Lockerbie Scrub (10°47'S, 142°28'E).

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Acknowledgements

This discovery was made on field work funded by the Australian Nature Conservation Agency (Endangered Species Program). We thank Trevor Beeton (DPI) for identifying the *Acacia* spp. on which the geckos were feeding, and Dr Geoff Monteith (QM) for identifying arthropod remains in the gut samples.

P.J. Couper, J.A. Covacevich, S.K. Wilson, *Queensland Museum, Box 3300, South Brisbane, 4101 Australia; 28 August 1995.*

CRASPEDELLINAE BAER, 1931 (PLATYHELMINTHES: TEMNOCEPHALIDA)
ECTOSYMBIONTS FROM THE BRANCHIAL CHAMBER OF AUSTRALIAN
CRAYFISH (CRUSTACEA: PARASTACIDAE)

LESTER R.G. CANNON AND KIM B. SEWELL

Cannon, L.R.G. & Sewell, K.B. 1995 12 01: Craspedellinae Baer, 1931 (Platyhelminthes: Temnocephalida) ectosymbionts from the branchial chamber of Australian crayfish (Crustacea: Parastacidae). *Memoirs of the Queensland Museum* 38(2): 397-418. ISSN 0079-8835.

Craspedellinae is recognised to include taxa of temnocephalids which live in the branchial chamber of Australian crayfish (Parastacidae) and are characterised by possession of one or more transverse papillate ridges across the dorsal body and crenulate (papillate) tentacles, i.e. 6 species of *Craspedella* Haswell, 1893, 5 of them new, all from eastern Australian *Cherax* spp., and 3 new species of a new genus all from Western Australian *Cherax* spp., and a new genus and species from *Euastacus bispinosus* from Victoria. □ *Temnocephalida*, *Craspedellinae*, *Craspedella*, *crayfish*, *ectosymbionts*, *taxonomy*.

Lester R.G. Cannon & Kim B. Sewell, Queensland Museum, PO Box 3300, South Brisbane, Queensland 4101, Australia; 20 October 1995.

Craspedella spenceri Haswell, 1893, described from the branchial chamber of *Astacopsis bicarinatus* Gray, 1845 [i.e. *Cherax destructor* Clark, 1936] from eastern Australia, is currently the only described species in the genus. Haswell (1893) characterised the species thus 'In the posterior half of the body, on the dorsal surface, are three transverse lamellae, 0.05mm in breadth, divided into about 15-20 rounded lobes, each tipped with a few papillae....'. The only other temnocephalid known to have dorsal papillae is *Notodactylus handschini* Baer, 1953 which occurs on the carapace of *Cherax* spp. from Australia and New Guinea. In *N. handschini* the papillae are not raised on ridges or lamellae and are retractile between the peculiar dorsal surface scales unique to this species (Jennings, Cannon & Hick, 1992). One scutariellid, *Bubalocercus sketi*, from cave shrimps in Slovenia and Croatia is reported to have papillae 'strewn' all over the body (Matjasic, 1990).

The habitat of *C. spenceri* within the branchial chamber is sheltered and this small 'less than 2mm', delicate and non-pigmented worm can easily go unnoticed; this is especially so when contrasted with the much larger '(about 0.5cm)' *Temnocephala dendyi* Haswell, 1893 which also occurs in the branchial chamber of *Cherax destructor*, or the large, and often pigmented, temnocephalids obvious on the external exoskeleton of many of Australia's crayfish.

The crayfish branchial chamber often supports a rich fauna (Alderman & Polglase, 1988; Cannon & Jennings, 1987; Jennings, 1988) including temnocephalids: the Scutariellidae are found

there in shrimps from Europe (Matjasic, 1990) and Asia (Baer, 1953); in Australia the monotypic Actinodactylellidae is found in the branchial chamber of burrowing crayfish, and several members of the Temnocephalidae are now known from shrimps and crabs (Cannon, 1993). Although *C. spenceri* remains the only described species in the genus, researchers have examined small branchial chamber dwelling temnocephalids from *Cherax* spp. and have referred to them as either *Craspedella* sp. (see Rohde, 1987a,b; Jones & Lester, 1992) or *C. spenceri* (see Cannon & Jennings, 1987).

Examination of the branchial chamber of crayfish *Cherax* spp. and *Euastacus* spp. collected from around Australia during 1990-1992 as part of an Australian Biological Resource Study of the Temnocephalida revealed new taxa which are described here.

MATERIALS AND METHODS

Live crayfish were captured in collapsible minnow traps baited with fatty mutton or canned cat food, and occasionally by dip netting, and were maintained for up to several hours in water from the habitat before they were dissected. To obtain living worms where captured crayfish were plentiful, the carapace was detached using strong forceps inserted anteriorly through the articular membrane and under the dorsal carapace, and the carapace and carcass placed into a shallow vessel containing water from the habitat. The inner surface of each branchiostegite (i.e., the branchiostegal membrane), the gills and the body wall were

searched with the aid of a dissecting microscope. Worms were collected on wooden points and transferred to a watch glass containing water. To obtain living worms where crayfish were rare, and needed intact for confirmation of host identification, several podobranchs were detached from the bases of the walking legs and placed in a watch glass containing water. Otherwise, the crayfish and any worms were killed and fixed by immersion in near boiling water (HW). All dismembered hosts, and when possible, additional intact host specimens were stored after HW fixation in 70% ethanol (A1) for subsequent taxonomic host identification and as a source of additional worm specimens. Where possible worms were drawn alive with the aid of a camera lucida, although for many species observations on living worms in the field was not possible.

For histology, living worms were flooded with fixative, usually cold 10% buffered formalin (Form), sometimes Bouin's fluid (Bouin) or acetic, formol, alcohol (AFA); some were fixed with Berland's fluid (10% formalin in glacial acetic acid). Some living worms removed from their host were fixed with hot water and transferred immediately to 10% phosphate buffered formalin (HW/Form). Where the crayfish host was collected by other than the collector of the worms the labelling convention - host collector/worm collector - is observed. Wholemounds were prepared by staining with either Mayer's or Harris' Haematoxylin (Hx) and mounting in Canada balsam. Serial sections were prepared from worms embedded in 56°C Paraplast, cut at 6-7µm and stained with Mayer's haematoxylin and eosin (H&E) or (rarely) using either Mallory's Trichrome (MT), Heidenhain's Azan (HA) or Heidenhain's Iron Haematoxylin (HII) and mounted in Depex. All measurements were made with the aid of a camera lucida.

For scanning electron microscopy (SEM) worms were fixed by flooding with either (1) hot water (approx. 90°C), then transferred to 10% phosphate buffered formalin (HW/Form), or (2) cold 3% glutaraldehyde (4°C). Fixed worms were washed several times in distilled water to remove surface contamination, dehydrated in a graded alcohol series, critical point dried, mounted on stubs, coated with gold, and examined with a Hitachi S-530 SEM operating at 20 or 25kV.

For examination of the cirrus, worms were placed on a slide in a drop of de Faure's (deF) mounting medium (distilled water 50ml; chloral hydrate 50g; glycerol 20ml and gum arabic 30g) on a microscope slide either alive, or in the case

of fixed specimens after rinsing in distilled water for 2-5 days to remove fixative, covered with a coverslip and examined using bright field and Nomarski microscopy. This technique clears the soft body tissue of the worms and provided much clearer images of the sclerotic male copulatory organ than those from stained wholemounts. Fixed worms cleared less effectively than live worms when placed in de Faure's medium. The shape of the vaginal cavity and its pattern of ridges and folds were also revealed by Faure's medium.

Taxonomic descriptions of worm species were prepared initially with the aid of the DELTA program (Dallwitz & Paine, 1986) and based on measurements from the type series. Terminology follows that discussed by Cannon (1993). Material is deposited in the collections of the Queensland Museum (QM) and wholemounts are designated (WM), de Faure's cirrus preparations (CP) and serial sections (LS, TS or FS) - longitudinal, transverse or facial sections: the number of slides in the series is given in brackets. Camera lucida drawings were scanned and used as templates for illustrations which were prepared using Adobe *Illustrator*, and photomicrographs were scanned from 35mm slide or negative film onto Kodak Photo CD, edited and assembled into plates using Adobe *Photoshop*.

MEASUREMENTS AND TERMINOLOGY

Considerable variation in the relative size, shape and position of internal structures was observed in living worms. This plasticity of shape and further distortion caused by the effects of fixative indicate that measurements are valuable only as a guide to the size and shape of the worms and their internal structures. Thus, the measurements we provide for soft structures and the cirrus are taken only from the large mature worms which comprise respectively the type series and de Faure's cirrus preparation series.

The terminology we use to describe the male reproductive structures essentially follows Cannon (1993). However, some reiteration and refinement of the terms are necessary. Following Cannon (1993), we term a cirrus the entire sclerotic male copulatory organ comprised of an introvert (flexible distal eversible region armed with spines) and shaft (rigid, tapering, proximal, tubular region). The shaft tapers proximal to distal and is further classified to have the shape of either a funnel, a goblet or a cone. Funnel or goblet shaped shafts have a wide proximal region which tapers rapidly to form a narrow, tubular

distal region. Light microscopy reveals that the introvert is comprised of (1) an inner wall of thin sclerotic material which appears attached to, and effectively makes a continuation of, the shaft and from which the spines project inward and distally when not everted and (2) an outer layer of presumably sclerotic material optically distinct from the inner wall i.e., the swelling or enlargement described by Cannon (1993). The swelling varies in thickness over the length of the introvert being thinnest distally and continues proximally for a short distance past the base of the introvert to the distal region of the shaft. Our descriptions of the cirrus refer to the inverted state of the organ.

Measurements of cirrus length were made along the outside of the shaft wall but inside the introvert swelling. Measurements of total cirrus length were made along the longest side of the organ and include the introvert. Measurements of the width of the introvert base include the thickness of the shaft walls but exclude the introvert swelling. Measurements for the copulatory bulb exclude the cirrus. The arrangement and orientation of the prostate duct reservoirs within the copulatory bulb is characterised as approximately either parallel, diagonal, or at right angles in relation to the longitudinal axis of the copulatory bulb.

SYSTEMATICS

CRASPEDELLINAE Baer, 1931

DIAGNOSIS

Temnocephalidae with oval or elliptical body slightly dorso-ventrally compressed, without lateral flanges and with five similar anterior tentacles. Tentacles with an annulate or crenulate appearance derived from prominent, conical, ciliated papillae arranged in near regular rows along and around a central axis. Rhabdite tracts to all tentacles, but most conspicuous in central three tentacles, with pore openings most concentrated in the ventro-distal region just posterior to the tip. Pigment confined to a single dorsal pair of eyes at the base of the tentacles. Posterior sucker pedunculate, strongly muscled, with a circular adhesive disc and marginal valve. Dorsal surface without imbricating scales, but with one or more transverse body ridges, bearing raised papillae; with dorsal body ridges arranged radially posterior to the most posterior transverse row also with raised papillae. Without locomotory cilia. Buccal cavity or pre-pharynx inconspicuous; pharynx directed antero-ventrally, rudimentary, undi-

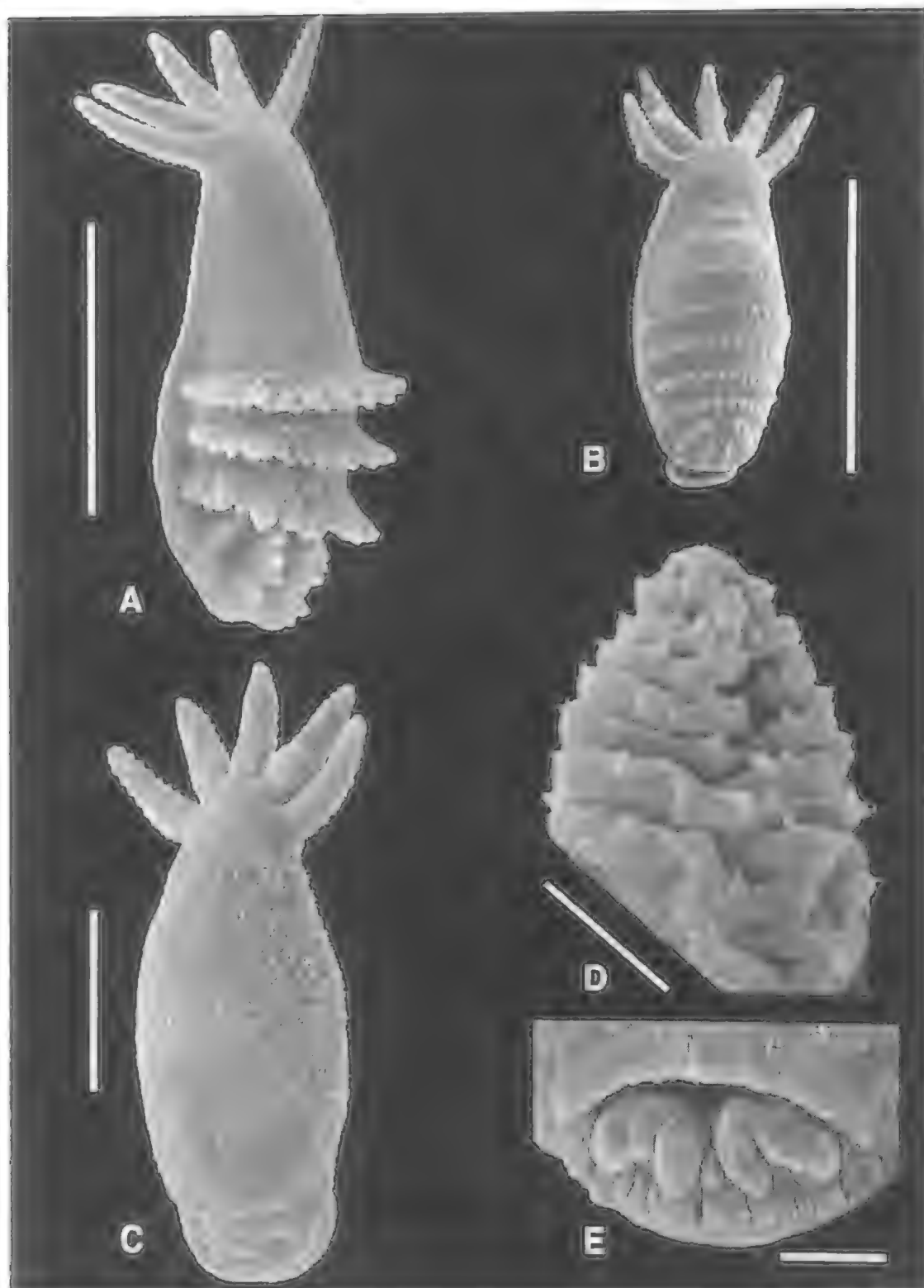
vided; pharynx sphincters equal; oesophagus inconspicuous; gut without colour or septa. Gut as wide as long and usually seen extending posteriorly further on the right. Major nerve trunks inconspicuous; eyes present, spherical to ovoid, discrete but close; pigment granules irregular, black-brown and mainly small. Longitudinal and circular muscles of body wall usually of equal strength; body dorso-ventral muscles weak. Attachment muscles of pharynx weak. Muscles controlling the male organ and about seminal vesicle and copulatory bulb strong. Gonopore mid-ventral in posterior third of body; genital atrium commodinus; without bursa copulatrix (but atrium may function as a bursa). Ovary spherical to ovoid; vesicula resorbens usually spherical to ovoid/kidney-shaped. Vagina muscular, usually with bulbous sphincter distally; vaginal cavity without teeth but delineated by prominent longitudinally oriented ridges and folds; seminal receptacle single; vitellaria scattered. Testes, two pairs anterior and posterior, spherical to ovoid, positioned lateral and posterior to gut respectively, smooth to follicular. Ejaculatory sac where present contained in copulatory bulb. Prostate secretion fills copulatory bulb around ejaculatory duct. Disc glands scattered across dorsal body at about the posterior of posterior testes. Small, slender worms up to 2mm *in vivo*. Inhabiting the branchial chamber of their hosts.

REMARKS

Cannon (1986) recognised three families within the Temnocephalida - the monotypic Actinodactylellidae from Australia, the Scutariellidae from Europe and Asia, and the large and diverse Temnocephalidae from Madagascar, Asia, Australasia, and South and Central America.

Several genera of the Temnocephalidae are monotypic, *Craspedella spenceri* being unique in having papillae raised on dorsal ridges (Haswell, 1893). Baer (1931) originally proposed a separate family for this species, giving the following diagnosis:

"Temnocephalids of rather small size with five mobile tentacles at the anterior end. In the posterior region of the worm are three pairs of small tentacles situated on the edges of the animal and joined, two by two, on the dorsal surface, by a type of small dentate fringe. Behind the last fringe, at the posterior end, are four more small tentacles. The pharynx is rudimentary. The other anatomical characters are identical with those of the Temnocephalidae."



Baer (1931) obviously misinterpreted the description of Haswell (1893) and believed the edges of the papillate ridges (fringes) were small lateral tentacles. In fact the papillae are not necessarily larger than those elsewhere on the ridges and are not '*trois paires de petits tentacles situés sur les bords de l'animal*'. Regardless, Bresslau & Reisinger (1933) considered these characters insufficient to create a new family for this one species and Hyman (1951) and Baer (1961) accepted this. The discovery of new taxa, all sharing similar morphology, prompts the delineation of this group from the remainder of the Temnocephalidae.

Type genus: *Craspedella* Haswell, 1893

Other genera: *Heptacraspedella* gen. nov., *Zygopella* gen. nov.

KEY TO CRASPEDELLINAE BAER, 1931

1. With more than one transverse papillate ridge on dorsal body and without pits, but with four papillate ridges which radiate towards the body margin behind the most posterior transverse ridge 2
- With a single transverse papillate ridge on posterior dorsal body and a pair of posterior pits defined dorsally by a papillate ridge 3
2. With 3 transverse papillate dorsal ridges *Craspedella* 5
- With 7 transverse papillate dorsal ridges *Heptacraspedella peratus* gen. et sp. nov.
3. Cirrus small, cone shaped and lacking large spines 4
- Cirrus large, cone-shaped with large spines *Z. deimata* sp. nov.
4. Cirrus with wide introvert opening and junction between introvert and shaft oblique *Z. pista* sp. nov.
- Cirrus with narrow introvert opening; tentacles very rugose *Z. stenota* sp. nov.
5. Cirrus shaft distal region not reflexed; introvert not permanently everted, armed with spines 6
- Cirrus shaft distal region reflexed; introvert permanently everted, spines reduced to be flat, overlaid and 'plate-like' *C. pedum* sp. nov.
6. Cirrus not slender, thick-walled 7

Cirrus slender, thin-walled *C. gracilis* sp. nov.

7. Cirrus shaft not cone-shaped and without thick proximal rim 8
- Cirrus shaft cone-shaped with thick proximal rim *C. shorti* sp. nov.
8. Cirrus shaft goblet-shaped; vagina with distinct 'lateral pocket' 9
- Cirrus shaft funnel-shaped with wide proximal opening; vagina without distinct 'lateral pocket' *C. spenceri*
9. Cirrus shaft: ratio of length of tubular distal region to length of introvert about equal and never less than 1:1 *C. yabba* sp. nov.
- Cirrus shaft: ratio of length of tubular distal region to length of introvert about 0.7:1 and always less than 1:1 *C. simulator* sp. nov.

Craspedella Haswell, 1893

DIAGNOSIS

Craspedellinae with three dorsal papillate ridges in the posterior half of the body and, behind the last ridge, four short posterior papillate ridges radiating towards the posterior body margin. Excretory ampullae coiled, spherical to ovoid but not elongate. Vagina muscular, with distinct distal sphincter.

TYPE SPECIES

Craspedella spenceri Haswell, 1893

OTHER SPECIES

Craspedella gracilis sp. nov.
Craspedella pedum sp. nov.
Craspedella shorti sp. nov.
Craspedella simulator sp. nov.
Craspedella yabba sp. nov.

ETYMOLOGY

Haswell (1893) provided no derivation of the name. Clearly it is from *kraspedon* (Greek; masculine; edge). The diminutive does not change the gender, so *Craspedella* is masculine meaning 'little edge', a reference to the dorsal papillate ridges.

FIG. 1. Scanning electron micrographs of genera of Craspedellinae from type localities. Specimens fixed HW/Form. A, *Craspedella spenceri* Haswell, 1893. Note prominent lamellae. Scale = 500µm. B, *Heptacraspedella peratus* gen. et. sp. nov. Scale = 500µm. C, *Zygopella pista* gen. & sp. nov. Scale = 200µm. Specimens fixed 3% glutaraldehyde. D, dorsal view of left lateral tentacle of *Zygopella stenota* sp. nov. showing rugose crenulations. Scale = 20µm. E, posterior end of *Zygopella pista* showing paired posterior pits. Scale = 50µm.

***Craspedella spenceri* Haswell, 1893**
(Figs 1A,2,3, 4A, 10A,E)

MATERIAL EXAMINED

TYPE SPECIMENS (Lost, see remarks).

NEOTYPE QMGL18489 (WM), ex *Cherax destructor* Clark, 1936 from Condamine R., Warwick, QLD (28°11.39'S; 151°57.50'E) 24/Oct/1992 Sewell K.B. & Sewell S.G. HW/Form/Hx.

OTHER MATERIAL: from QLD:- ex *Cherax destructor* same data as neotype HW/Form/H&E QMGL18490-18491 (LS[1,1]), 4/Aug/1994 Sewell K.B. & Joffe B. HW/deF QMGL18610 cirrus inverted (CP[2], 2 adult specimens), QMGL18611 cirrus everted (CP[2], 2 adult specimens), 1/Sep/1994 Sewell K.B. HW/deF QMGL18612 cirrus inverted (CP[8], 8 adult specimens): from Western R., 1.5km from Winton on Jundah Rd., QLD (22°24.2'S; 143°02.2'E) 22/Nov/1990 Cook S./Cannon L.R.G. Form/Hx QMGL18492 (WM): from Thompson R. at Longreach Waterhole, Longreach, QLD (23°24.7'S; 144°13.8'E) 2/Oct/1990 Cannon L.R.G. & Sewell K.B. HW/Form/Hx QMGL18493-18498, Bouin/H&E QMGL18499-18500 (LS[1,1]): from Marlong Ck., Mt. Moffat N.P., QLD (25°02'S; 147°54'E) 26/Sep/1986 Monteith N.C. Al/Hx QMGL18501-18503 (WM): from Dawson R., Taroom, QLD (25°39'S; 149°48'E) 3/Dec/1986 Cannon L.R.G. & Jennings J. Form/Hx QMGL18504 (WM): from Bungil Ck., Roma, QLD (26°30'S; 148°48'E) 2/Dec/1991 Cannon L.R.G. & Jennings J. Form/H&E QMGL18505 (WM), FAA/H&E QMGL18506 (LS[5]): from Eukey, damat, QLD (28°46.2'S; 151°59.2'E) 18/Apr/1990 Cook S./Cannon L.R.G. Form/Hx QMGL18507-18508 (WM), 17/Apr/1990 Form/Hx QMGL18509 (WM), QMGL18510 (LS[1]): from Willows gemfield, in dam beside road, QLD (23°45'S; 147°25'E) 20/Sep/1990 Cook S./Cannon L.R.G. Form/H&E QMGL18511-18513 (LS[1,1,1]): ex *Cherax depressus* complex sensu Riek, 1951 from Wallaby Ck., on Henderson Rd. 0.2km from Mt. Cotton Rd. junction, Sheldon, QLD (27°34.21'S; 153°12.78'E) 22/Sep/1994 Sewell K.B., Joffe B., Solovei I.V. & Solovei S.B. Form/Hx QMGL18514-18516 (WM):

From NSW:- ex *Cherax destructor*, from Lake Madgwick, U.N.E. campus Armidale, NSW (30°31'S; 151°40'E) 23/May/1991 Zoology Dept. U.N.E. Bouin/Hx QMGL18517-18523 (WM), Bouin/H&E QMGL18524 (flattened specimen LS [2]), QMGL18525-18527 (LS[1,1,2]): from Yarunga Ck. trib., 1.2km NW Fitzroy Falls, Morton N.P., NSW (34°38.4'S; 150°28.4'E) 19/Sep/1991 Cannon L.R.G. & Sewell K.B. Form/Hx QMGL18528-18529 (WM), QMGL18530-18531 (LS[1,1], HW/Form/H&E QMGL18532 (LS[1]):

From SA:- (all collected by Beveridge I., fixed in Berland's fluid and stained in Mayer's Haemalum as wholemounts); ex *Cherax destructor* from Lake Alexandrina, via Clayton (35°25'S; 139°10'E) 20/Jan/1989 QMGL18533: from Cooper Ck.

26/Nov/1988 QMGL18534: from the Narrows, via Clayton 2/Dec/1988 QMGL18535: from Bordertown (36°18'S; 140°46'E) 31/Oct/1988 QMGL18536: from Lake Merreti (34°01'S; 140°46'E) 3/Dec/1988 QMGLGL 18537: from Avenue Ra. 18/Oct/1988 QMGL18538: from Mt. Benson (37°02'S; 139.49'E) 18/Oct/1988 QMGL18539: from Bool Lagoon (37°09'S; 140°43'E) 4/Nov/1989 QMGL18540.

DESCRIPTION

External. Body from posterior margin to tip of tentacles 1109µm, to eyes 761µm long and 522µm wide. Posterior disc 304µm in diameter; peduncle 162µm in diameter. Transverse body ridges form pronounced lamellae divided into lobes tipped with clusters of papillae. Epidermis about 2-3µm high dorsally and ventrally.

General Anatomy. Pharynx 65µm across. Excretory ampullae about 70µm across. Eyes about 15µm across.

Reproductive System. Female. Ovary 90µm across. Vesicula resorbiens 70µm long, 35µm wide, wall about 10µm thick, embedded in gut wall. Seminal receptacle about 100µm long and 27µm wide. Vagina long.

Male. Anterior testes about 110µm long, 70µm wide. Posterior testes about 110µm long, 70µm wide. Seminal vesicle 80µm long, 50µm wide. Copulatory bulb 69µm long, 62µm wide, with ejaculatory sac. Prostate duct reservoirs parallel. Cirrus (based on 10 adult fully inverted specimens fixed HW/deF ex QMGL18611 and GL18612) 176-196µm (\bar{x} =185µm) long in total. Shaft funnel-shaped, curved, thick walled, with distal region less than length of introvert; proximal opening 46-76µm (\bar{x} =60µm) wide, with narrow rim. Introvert strongly curved, 13-17µm (\bar{x} =15µm) wide at base, longer side 71-83µm (\bar{x} =78µm) long, shorter side 38-49µm (\bar{x} =43µm) long (i.e. introvert about 5 times longer than width of introvert base), with clearly asymmetrical swelling i.e. much wider on longer side, distal opening 20-27µm (\bar{x} =24µm) wide.

Hosts. *Cherax destructor* Clark, 1936: *Cherax depressus* group sensu Riek, 1951: Parastacidae.

Locality. Murray-Darling river system and east coast streams.

REMARKS

Type specimens were not located despite a careful search of the collections at the Australian Museum, Sydney and at the McLeay Museum at the University of Sydney. Haswell worked in both institutions, but evidently failed to lodge type specimens of the worms he described. A search for data which might indicate the localities

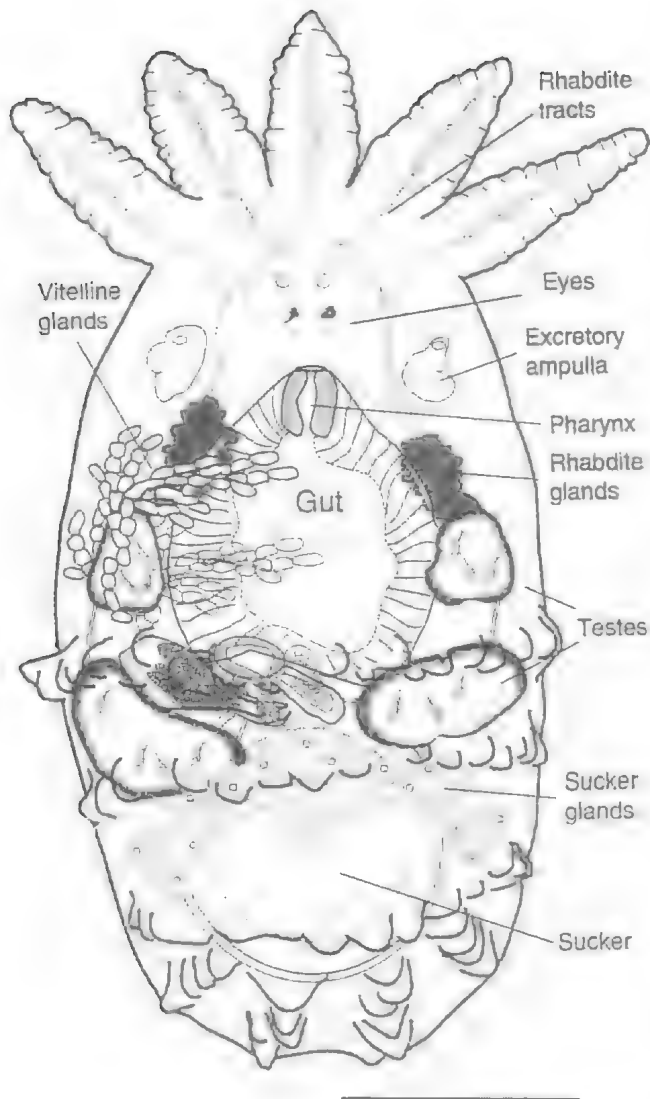


FIG 2. *Craspedella spenceri* Haswell, 1893, Neotype. Scale = 250µm.

from which he obtained crayfish hosts and thus indicate type localities failed to provide useful information. In Haswell's time the crayfish *Asiatopsis bicarinatus* Gray, 1845 was the name for what is now known to be several species of *Cherax* found in eastern Australia. *Cherax destructor*, however, is by far the most common and wide spread of species and is found throughout the Murray-Darling system. The specimens we obtained from this host conform closely with the majority of Haswell's description and thus confirm the validity of the species. However,

Haswell (1893) apparently confused the cirrus of *C. spenceri*, in our view the most important taxonomic character, with that of another closely related species described below (see Haswell, 1893 Plate XIII, Fig. 21). Moreover, the widespread distribution of *C. spenceri* may result in some variation in body size and form between localities and hosts (see below section on *Craspedella* sp. from *Cherax albidus* Clark, 1936). Since nomenclatural instability could potentially develop and thus circumstances are somewhat exceptional, a neotype has been erected

***Craspedella gracilis* sp. nov.**
(Fig. 4B)

MATERIAL EXAMINED

HOLOTYPE: QMGL18429 (WM), ex *Cherax depressus* from Marlborough creek beside caravan park, QLD (22°49.2'S; 149°53.2'E) 21/Sep/1990 Cannon L.R.G. & Sewell K.B. HW/Form/Hx.

PARATYPES: Same data as holotype, QMGL18430-18431 (WM), QMGL18432 (LS[1]).

OTHER MATERIAL: Same data as holotype, HW/Form/Hx QMGL18433-18435 (WM), QMGL18436 (LS[1]), HW/AFA/H&E QMGL18437 (WM), HW/Form/deF QMGL18613 cirrus inverted (CP[2], 4 adult, 1 young specimens).

DESCRIPTION

External: Body from posterior margin to tip of tentacles 510-605µm (\bar{x} =550µm), to eyes 323-391µm (\bar{x} =354µm) long and 170-198µm (\bar{x} =187µm) wide; Posterior disc 102-115µm (\bar{x} =106µm) in diameter; peduncle 58-68µm (\bar{x} =62µm) in diameter. Transverse body ridges do not form lamellae. Epidermis about 2-3µm high dorsally and ventrally.

General Anatomy. Pharynx 27-34µm (\bar{x} =30µm) long, 30-34µm (\bar{x} =33µm) wide, Gastrodermis about 25µm high. Excretory ampullae 24-34µm (\bar{x} =31µm) long, 10-17µm (\bar{x} =15µm) wide. Eyes about 8µm across.

Reproductive System. Female. Ovary 30-34µm (\bar{x} =31µm) across. Vesicula resorbens 45-68µm

($\bar{x}=58\mu\text{m}$) across, wall 3–5 μm thick. Seminal receptacle about 36 μm long, 9 μm wide.

Male. Anterior testes about 34–41 μm ($\bar{x}=39\mu\text{m}$) long, 25–30 μm ($\bar{x}=28\mu\text{m}$) wide. Posterior testes about 52–68 μm ($\bar{x}=60\mu\text{m}$) long and 29–41 μm ($\bar{x}=35\mu\text{m}$) wide. Seminal vesicle 54–60 μm ($\bar{x}=56\mu\text{m}$) long, 25–36 μm ($\bar{x}=31\mu\text{m}$) wide. Copulatory bulb, 27–34 μm ($\bar{x}=31\mu\text{m}$) long, 30–37 μm ($\bar{x}=33\mu\text{m}$) wide, with ejaculatory sac. Prostate duct reservoirs parallel. Cirrus (based on 4 fully inverted adult specimens ex QMGL18613) 157–168 μm ($\bar{x}=163\mu\text{m}$) long in total. Shaft narrow, goblet-shaped, curved, thin-walled, with distal region about same length as introvert; proximal opening 22–29 μm ($\bar{x}=24\mu\text{m}$) wide, with narrow rim. Introvert slightly curved, 6–7 μm ($\bar{x}=7\mu\text{m}$) wide at base, longer side 61–61 μm ($\bar{x}=61\mu\text{m}$) long, shorter side 44–52 μm ($\bar{x}=48\mu\text{m}$) long (i.e. introvert about 9 times longer than width of introvert base), with narrow asymmetrical swelling i.e. wider on longer side, distal opening angled, about 6–8 μm ($\bar{x}=7\mu\text{m}$) wide.

Hosts. *Cherax depressus* complex *sensu* Riek, 1951: Parastacidae.

Locality. Marlborough, central eastern QLD.

ETYMOLOGY

Latin, *gracilis*, slender, referring to the slenderness of the cirrus.

REMARKS

The slender, delicate cirrus clearly distinguishes this species. In wholemounted specimens the cirrus shaft is often severely contorted, and the introvert considerably narrowed, presumably as a result of the effects of fixation.

Craspedella pedum sp. nov. (Figs 4C, 10C)

Craspedella sp. Sewell & Cannon, 1995: 151; Sewell & Whittington, 1995: 1121; Watson, Rohde & Sewell, 1995: 131.

MATERIAL EXAMINED

HOLOTYPE: QMGL18461 (WM), ex *Cherax quadricarinatus* (von Martens, 1868) from University of Queensland aquaculture ponds, Pinjarra Hills, QLD (27°32.38'S; 152°55.18'E) 15/May/1992 Sewell K.B. HW/Form/Hx.

PARATYPES: Same data as holotype, QMGL18462 (WM), 19/Apr/1991 HW/Form/Hx QMGL18463 (WM), 30/Mar/1992 Bouin/H&E QMGL18464 (LS[1]), 22/Dec/1992 Bouin/MT QMGL18465 (LS[1]).

OTHER MATERIAL: ex *Cherax quadricarinatus* (Von Martens, 1868) from University of Queensland aquaculture ponds, Pinjarra Hills, QLD (27°32.38'S; 152°55.18'E) 1991–1993 HW/Form/Hx QMGL18466–18472 (WM), Bouin/Hx QMGL18473 (LS[1]), Form/HA QMGL18474 (LS[1]), Form/HH QMGL18475 (LS[1]), HW/deF QMGL18626 cirrus everted (CP[5]) 10 adults, 15 juveniles or damaged; (Mitchell R. stock) from Walkamin, D.P.I. Research Station aquaculture ponds, QLD (17°08'S; 145°25'E) 25/Sep/1990 Cannon L.R.G. & Sewell K.B. AFA/Hx QMGL18476 (WM), Bouin/Hx QMGL18477 (WM): from East Leichardt R., 50km SW Mt. Isa, QLD (20°56'S; 139°45'E 3/May/1993) Monteith G.B. Al/Hx QMGL18478–18488 (WM).

DESCRIPTION

External. Body from posterior margin to tip of tentacles 739–896 μm ($\bar{x}=800\mu\text{m}$), to eyes 497–616 μm ($\bar{x}=544\mu\text{m}$) long and 223–346 μm ($\bar{x}=278\mu\text{m}$) wide. Posterior disc 157–186 μm ($\bar{x}=171\mu\text{m}$) in diameter; peduncle 69–107 μm ($\bar{x}=83\mu\text{m}$) in diameter. Transverse body ridges do not form lamellae. Epidermis about 2–3 μm high dorsally and ventrally.

General Anatomy. Pharynx 37–48 μm ($\bar{x}=43\mu\text{m}$) long, 27–39 μm ($\bar{x}=33\mu\text{m}$) wide. Gastrodermis about 30 μm high. Excretory ampullae about 44–62 μm long ($\bar{x}=51\mu\text{m}$) long, 27–45 μm ($\bar{x}=34\mu\text{m}$) wide. Eyes about 14 μm across.

Reproductive System. Female. Ovary 31–55 μm ($\bar{x}=45\mu\text{m}$) long, 27–47 μm ($\bar{x}=37\mu\text{m}$) wide. Vesicula resorbens 91–130 μm ($\bar{x}=106\mu\text{m}$) long, 56–89 μm ($\bar{x}=72\mu\text{m}$) wide, wall about 10 μm thick. Seminal receptacle about 34 μm long, 11mm wide.

Male. Anterior testes 46–67 μm ($\bar{x}=58\mu\text{m}$) long, 31–53 μm ($\bar{x}=45\mu\text{m}$) wide. Posterior testes 72–94 μm ($\bar{x}=81\mu\text{m}$) long, 34–50 μm ($\bar{x}=44\mu\text{m}$) wide. Seminal vesicle strongly muscled 105–144 μm ($\bar{x}=118\mu\text{m}$) long, 41–58 μm ($\bar{x}=48\mu\text{m}$) wide. Copulatory bulb 73–86 μm ($\bar{x}=79\mu\text{m}$) long, 73–98 μm ($\bar{x}=83\mu\text{m}$) wide, with ejaculatory sac. Prostate duct reservoirs parallel. Cirrus (based on 10 adult specimens ex QMGL18266) 236–283 μm ($\bar{x}=264\mu\text{m}$) long in total. Shaft funnel-shaped, strongly curved (reflexed) distally; proximal opening 69–112 μm ($\bar{x}=96\mu\text{m}$) wide, with narrow rim; outside wall of reflex widened at point of introvert 'eversion' muscle insertion. Introvert permanently everted, forming rigid flange 48–59 μm ($\bar{x}=54\mu\text{m}$) long; without obvious swelling. Spines reduced to be flat, overlaid, 'welded together' and 'plate-like'.

Hosts. *Cherax quadricarinatus* (Von Martens, 1868): Parastacidae.

Locality. Queensland.

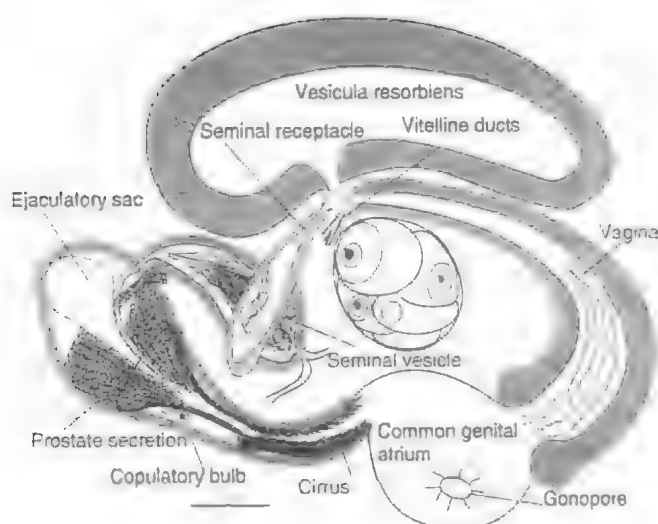


FIG. 3. Reproductive structures of *Craspedella spenceri*. Scale = 50µm.

ETYMOLOGY

Latin, *pedum*, shepherd's crook, referring to the u-shaped reflex of the distal portion of the cirrus shaft. This is a noun in apposition.

REMARKS

Morphology of the male cirrus is unique and serves to distinguish this species. The muscle insertion point of the introvert 'eversion' muscle on the reflex becomes thicker with age. The aberrant form of the apparently permanently everted introvert required that the standard measurement protocol had to be modified.

Craspedella shorti sp. nov. (Figs 4D, 10D)

MATERIAL EXAMINED

HOLOTYPE: QMGL18450 (WM), ex *Cherax depressus* from roadside gully on Mumford Rd., Nørangbah, QLD (27°12.34'S; 152°57.42'E) 18/Mar/1992 Short J./Sewell K.B. HW/Form/Hx.

PARATYPES: Same data as holotype, QMGL18451, (WM): ex *Cherax depressus* from Wallaby Ck., on Henderson Rd, 0.2km from Mt. Cotton Rd. junction, Sheldon Brisbane, QLD (27°34.21'S; 153°12.78'E) Cannon L.R.G. & Joffe B./Sewell K.B. 14/Sep/1994 Form/Hx QMGL18452 (WM), Bouin/H&E QMGL18453 (LS[1/1]).

OTHER MATERIAL: Same data as holotype, HW/Form/Hx QMGL18454-18455 (WM); ex *Cherax depressus* from Wallaby Ck., on Henderson Rd. 0.2km from Mt. Cotton Rd. junction, Sheldon Brisbane, QLD (27°34.21'S; 153°12.78'E) Cannon L.R.G. & Joffe

B./Sewell K.B. 14/Sep/1994 Form/Hx QMGL18456-18460 (WM), HW/dcF QMGL18614 cirrus inverted (CP[3], 3 adults), QMGL18615 cirrus everted (CP[5], 5 adult specimens).

DESCRIPTION

External. Body from posterior margin to tip of tentacles 414-761µm (\bar{x} =608µm), to eyes 352-515µm (\bar{x} =427µm) long and 311-435µm (\bar{x} =327µm) wide. Posterior disc 137-140µm (\bar{x} =138µm) in diameter; peduncle 65-90µm (\bar{x} =78µm) in diameter. Transverse body ridges do not form lamellae. Epidermis about 2µm high dorsally and ventrally.

General Anatomy. Pharynx 32-72µm (\bar{x} =56µm) long, 43-80µm (\bar{x} =58µm) wide. Gastrodermis about 27µm high. Excretory ampullae 45-60µm (\bar{x} =53µm) long, 21-30µm (\bar{x} =26µm) wide. Eyes about 13µm across. Posterior glands present and discharging in two postero-lateral regions (see remarks).

Reproductive System. Female. Ovary 40-43µm (\bar{x} =41µm) across. Vesicula resorbiens 93-126µm (\bar{x} =111µm) long, 93-72µm (\bar{x} =78µm) wide, wall 8-11µm thick. Seminal receptacle about 50µm long, 16µm wide.

Male. Anterior testes about 54-68µm (\bar{x} =60µm) long, 36-47µm (\bar{x} =43µm) wide. Posterior testes about 74-91µm (\bar{x} =81µm) long, 40-50µm (\bar{x} =45µm) wide. Seminal vesicle 97-112µm (\bar{x} =103µm) long, 40-49µm (\bar{x} =43µm) wide. Copulatory bulb 83-101µm (\bar{x} =93µm) long, 62-75µm (\bar{x} =68µm) wide, without ejaculatory sac. Prostate duct reservoirs at right angles (except in most proximal region of the bulb). Cirrus (based on 7 adult specimens (3 inverted, 4 everted) ex QMGL18614 and QMGL18615) 153-169µm (\bar{x} =161µm) long in total. Shaft cone-shaped, curved, thick walled; proximal opening 29-38µm (\bar{x} =32µm) wide, with very thick rim. Introvert not curved, 10-15µm (11µm) wide at base, both sides almost same length, longer side 45-47µm (\bar{x} =46µm) long, shorter side 42-47µm (\bar{x} =44µm) long (i.e. introvert about 4 times longer than width of introvert base), with near symmetrical swelling, distal opening 13-17µm (\bar{x} =15µm) wide.

Hosts. *Cherax depressus* complex *sensu* Riek, 1951: Parastacidae.

Locality. south eastern QLD.

ETYMOLOGY

For John Short, Crustacea Section QM who collected the host from which the first specimen was recognised

REMARKS

The prostate duct reservoirs in the copulatory bulb being at right angles to the long axis of the bulb form a distinctly baccate pattern which serves to distinguish this species, as does the thick proximal rim of the cirrus shaft. Postero-lateral glands similar to those observed for this species have been described previously (see Cannon, 1993). The nature of similar glands from *Temnocephala minor* are the subject of a separate study by Cannon & Watson (in press).

Craspedella simulator sp. nov.
(Figs 4E, 10F)

Craspedella spenceri: Cannon & Jennings, 1987

MATERIAL EXAMINED

HOLOTYPE: QMGL18541 (WM), ex *Cherax dispar* from Woodgate Lagoons, beside Childers to Woodgate Rd., QLD (25°07.4'S; 152°30.6'E) 6/Apr/1991 Sewell K.B. HW/Form/Hx.

PARATYPES: Same data as holotype, QMGL18542-18543 (WM); QMGL 18544 (LS[1]).

OTHER MATERIAL: From QLD:- ex *Cherax dispar* same data as holotype, QMGL18545-18553 (WM), QMGL18554 (LS[1]), 18/Sep/1990 Cannon L.R.G. & Sewell K.B. HW/Form/Hx QMGL18555 (WM), HW/Form/deF QMGL18816 cirrus inverted (CP[2], 5 adult, 2 young specimens); also ex *Cherax dispar* from Gap Ck., in Gap Ck. Reserve picnic ground, Brookfield, QLD (27°28.68'S; 152°55.71'E) 3/Sep/1984 Hall N. & Francis S. Bouin/Hx QMGL18556-18557 (WM), Bouin/H&E QMGL18558 (TS[2]), 12/Dec/1984 Cannon L.R.G. FAA/Hx QMGL18559-18563 (WM), FAA/H&E QMGL18564-18565 (LS[1,1]); from Wallaby Ck., on Henderson Rd. 0.2km from Mt. Cotton Rd. junction, Sheldon Brisbane, QLD (27°34.21'S; 153°12.78'E) Sewell K.B., Joffe B., Solovei I.V. & Solovei S.B. 19/Sep/1994 Form/Hx QMGL18566-18573 (WM), 14/Sep/1994 Cannon L.R.G. & Joffe B./Sewell K.B. deF QMGL18617 cirrus everted (CP[1], 1 adult specimen); ex *Cherax depressus* from Wallaby Ck., on Henderson Rd. 0.2km from Mt. Cotton Rd. junction, Sheldon, Brisbane, QLD (27°34.21'S; 153°12.78'E) Sewell K.B., Joffe B., Solovei I.V. & Solovei S.B. 19/Sep/1994 Form/Hx QMGL18574-18576 (WM); ex *Cherax destructor* from Thompson R. at Longreach Waterhole, Longreach, QLD (23°24.7'S; 144°13.8'E) 2/Oct/1990 Cannon L.R.G. & Sewell K.B. FAA/Hx QMGL18577 (WM), HW/Form/Hx QMGL18578 (WM); from Longreach, QLD (23°27'S; 144°15'E) 13/Dec/1990 Cook S./Cannon L.R.G. Form/H&E QMGL18579-18580 (WM);

from Condamine R., Warwick, QLD (28°11.39'S; 151°57.50'E) 24/Oct/1992 Sewell K.B. & Sewell S.G. HW/Form/Hx QMGL18581-18589 (WM).

From NSW:- ex *Cherax destructor* from a tributary of Yarunga Ck., 1.2km NW Fitzroy Falls, Morton N.P., NSW (34°38.4'S; 150°28.4'E) 19/Sep/1991 Cannon L.R.G. & Sewell K.B. HW/Form/Hx QMGL18590-18591 (WM), QMGL18592 (LS[1]); ex *Cherax cuspidatus* from Wauchope, roadside swamp beside 'Timbertown', NSW (31°28.4'S; 152°42.8'E) 15/Feb/1992 Sewell K.B. & Sewell S.G. HW/Form/Hx QMGL18593-18594, Form/Hx QMGL18595-18598 (WM), QMGL18599-18600 (LS[1,1]).

From SA:- (all collected by Beveridge 1, fixed in Berland's fluid and stained in Mayer's Haemalum as whole mounts); ex *Cherax destructor* from Tod R. (34°30'S; 135°51'E) 9/Mar/1989 QMGL18601; from Springbett, Gawler (34°36'S; 138°45'E) 23/Jun/1989 QMGL18602; from Murray R., Murray Bridge (35°07'S; 139°16'E) 10/Feb/1989 QMGL18603; from Onkaparinga R. (35°00'S; 138°49'E) 22/Nov/1989 QMGL18604; from Light R., Kapunda (34°21'S; 138°55'E) 1/Mar/1989, QMGL18605; from Inman R. (35°30'S; 138°31'E) 19/Nov/1988 QMGL18606; from Strawberry Hill Springs (34°31'S; 135°43'E) 9/Mar/1989 QMGL18607; from Broughton R., Spalding (35°30'S; 138°37'E) 29/Mar/1989 QMGL18608; from Gerard Yabbie Farm, Berri (34°17'S; 140°36'E) 19/Jun/1989 QMGL18609.

DESCRIPTION

External. Body from posterior margin to tip of tentacles 476-506µm (\bar{x} =486µm), to eyes 313-347µm (\bar{x} =331µm) long and 205-210µm (\bar{x} =207µm) wide; Posterior disc 95-110µm (\bar{x} =103µm) in diameter; peduncle 51-58µm (\bar{x} =55µm) in diameter. Transverse body ridges do not form lamellae. Epidermis about 2µm high dorsally and 3µm high ventrally.

General Anatomy. Pharynx 30-34µm (\bar{x} =31µm) long, 34-36µm (\bar{x} =35µm) wide, Gastrodermis about 20µm high. Excretory ampullae about 40µm long, 20µm wide. Eyes about 9µm across.

Reproductive System. Female. Ovary 32-36µm (\bar{x} =34µm) across. Vesicula resorbens 54-60µm (\bar{x} =56µm) across, wall 5-10µm thick. Seminal receptacle about 58µm long, 19µm wide. Vagina with pronounced lateral pocket.

Male. Anterior testes about 30-44µm (\bar{x} =38µm) long, 18-40µm (\bar{x} =31µm) wide. Posterior testes about 38-78µm (\bar{x} =56µm) long and 27-35µm (\bar{x} =31µm) wide. Seminal vesicle 54-63µm (\bar{x} =58µm) long, 23-26µm (\bar{x} =25µm) wide. Copulatory bulb, 34-40µm (\bar{x} =38µm) long, 44-49µm (\bar{x} =47µm) wide, with ejaculatory sac. Prostate duct reservoirs parallel. Cirrus (based on 5 adult specimens ex QMGL18816) 176-186µm

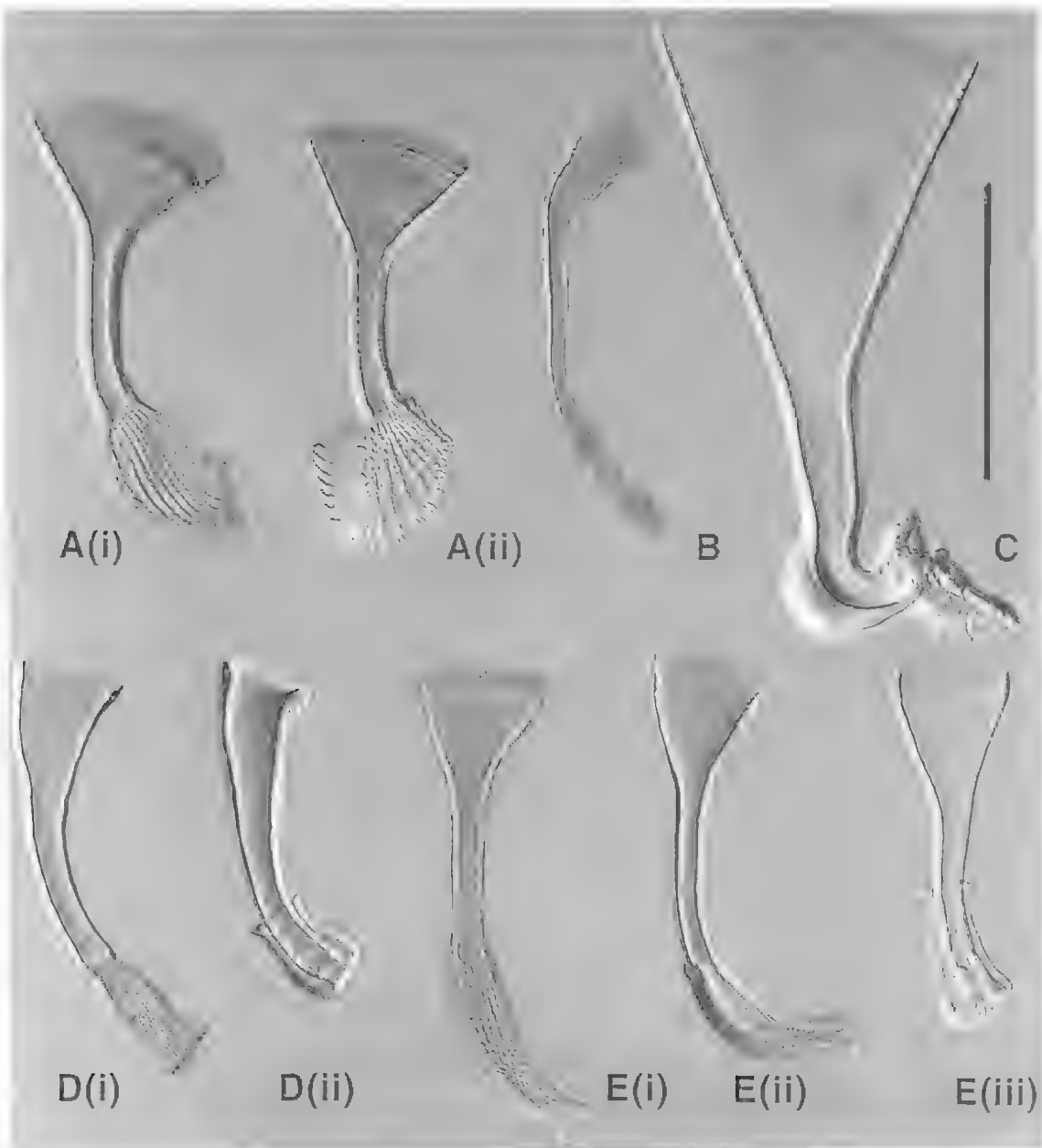


FIG 4. Nomarski interference photomicrographs of cirri of adult worms ex type host and locality unless stated: A, *Craspedella spenceri* (i) inverted; (ii) partially everted. B, *Craspedella gracilis* sp. nov., inverted; C, *Craspedella pedum* sp. nov.; D, *Craspedella shorti* sp. nov. (i) inverted, (ii) partially everted; *Craspedella simulator* sp. nov. (i) inverted, (ii) inverted ex *Cherax dispar* from Wallaby Ck., Sheldon, QLD, (iii) partially everted ex *Cherax dispar* from Wallaby Ck, Sheldon, QLD. Scale = 100 μ m.

(\bar{x} =180 μ m) long in total. Shaft, goblet-shaped, slightly curved, thick-walled, with distal region shorter than length of introvert; proximal opening 38-43 μ m (\bar{x} =41 μ m) wide, with narrow rim. In-

trovert curved, 11-13 μ m (\bar{x} =12 μ m) wide at base, longer side 70-77 μ m (\bar{x} =72 μ m) long, shorter side 64-70 μ m (\bar{x} =66 μ m) long (i.e. introvert about 6 times longer than width of introvert base), with

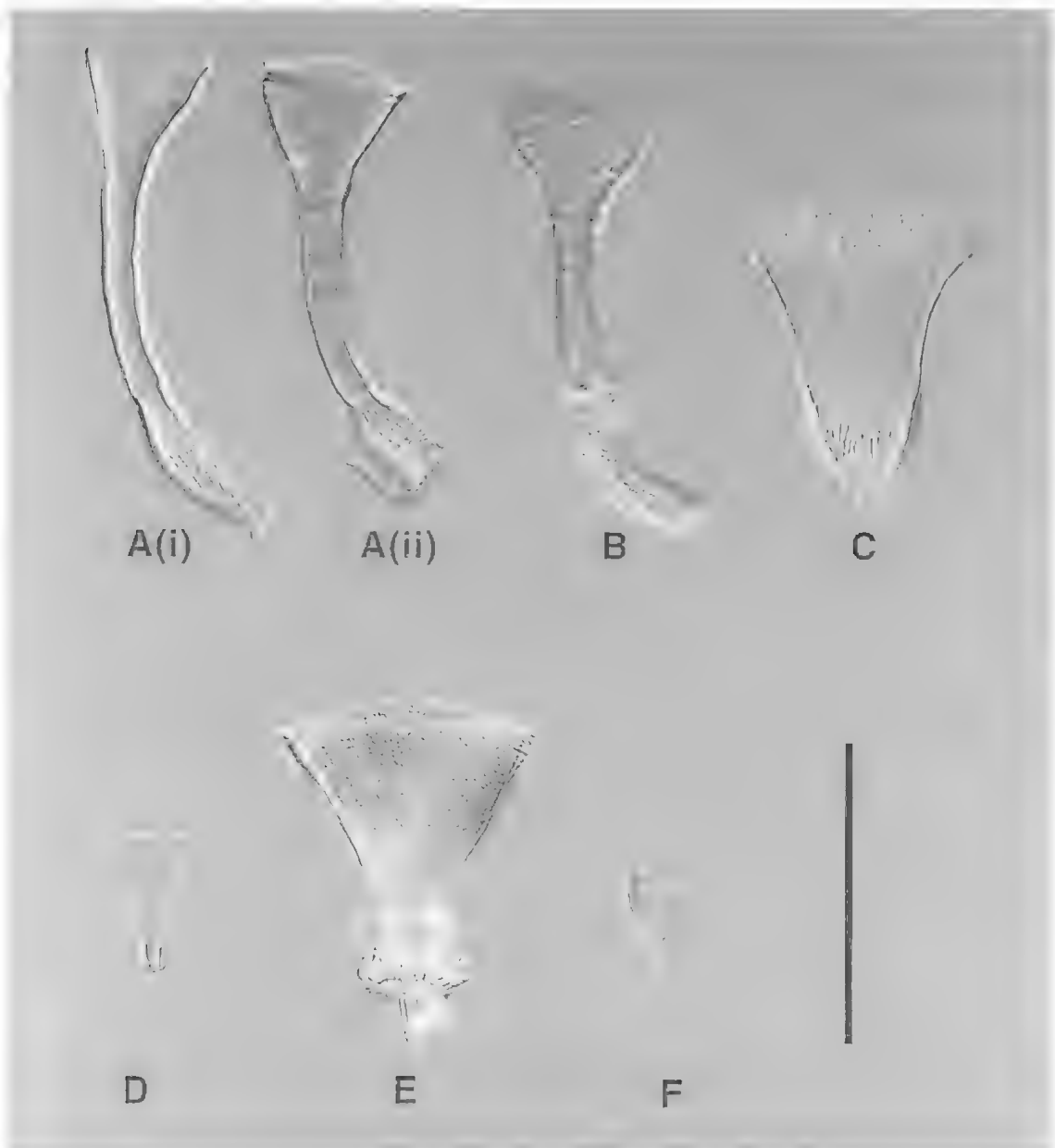


FIG. 5. Nomarski interference photomicrographs of cirri of adult worms ex type host and locality unless stated: A, *Craspedella yabba* sp. nov., (i) inverted (ii) partially everted; B, *Craspedella* sp., inverted; C, *Heptacraspedella peratus* gen. & sp. nov., part everted; D, *Zygopella pista* gen. & sp. nov., partially everted; E, *Zygopella deimata* sp. nov. partially everted; F, *Zygopella stenota* sp. nov., inverted. Scale = 100µm.

clearly asymmetrical swelling i.e. much wider on longer side, distal opening 11-17µm (\bar{x} =14µm) wide.

Hosts. *Cherax cuspidatus* Riek, 1969; *Cherax depressus* complex *sensu* Riek, 1951; *Cherax destructor* Clark, 1936; *Cherax dispar* Riek, 1951: Parastacidae.

Locality. eastern Australia.

ETYMOLOGY

Latin, *simulator*, an imitator which refers to the close resemblance of this species to that of *C. spenceri*. This is a noun in apposition.

REMARKS

Although superficially resembling *C. spenceri* with which it frequently co-inhabits the branchial chamber this worm is generally smaller, has a more elongate body shape, much less pronounced transverse body ridges, i.e. they do not form lamellae, a goblet-shaped cirrus with a narrower introvert, and a smaller vagina which has a pronounced lateral pocket (Fig. 10F).

***Craspedella yabba* sp. nov.**
(Fig. 5A)

MATERIAL EXAMINED

HOLOTYPE: QMGL18438 (WM), ex *Cherax depressus* from Conondale Ra., State Forest 792, QLD (26°47'S; 152°32'E) 16/Sep/1994 Smith G./Sewell K.B. Bouin/Hx.

PARATYPES: Same data as holotype, Form/Hx QMGL18439 (WM), Bouin/H&E QMGL18440 (FS [1]), GL 18441 (LS[1]).

OTHER MATERIAL: Same data as holotype, Form/Hx QMGL18442 (WM), Bouin/H&E QMGL18443 (LS[1]), HW/deF QMGL18618 cirrus inverted (CP[1], 1 adult specimen), QMGL18619 cirrus everted (CP[2], 2 adult specimens); ex *Cherax dispar* from Booloumba Ck. at first road crossing E of Little Yabba Ck. Rest Area (26°37.0'S; 152°39.1'E) 23/Mar/1990 Cannon L.R.G. & Sewell K.B. HW/AFA/Hx QMGL18444 (WM), Bouin/H&E QMGL18446-18447 (LS[1,1]); from Conondale Ra., QLD (26°44'S; 152°43'E) 17/Nov./1983 Cannon L.R.G. Form Hx QMGL18445 (WM), FAA/H&E QMGL18448 (LS[1]), QMGL18449 (LS[2]).

DESCRIPTION

External. Body from posterior margin to tip of tentacles 336-380µm (\bar{x} =358µm), to eyes 258-285µm (\bar{x} =270µm) long and 200-221µm (\bar{x} =211µm) wide. Posterior disc 95µm in diameter; peduncle about 58µm in diameter. Transverse body ridges do not form lamellae. Epidermis about 2-5µm high dorsally and ventrally.

General Anatomy. Pharynx 25-27µm (\bar{x} =26µm) long, 25-27µm (\bar{x} =26µm) wide. Gastrodermis about 37-44µm high. Excretory ampullae about 28µm long, 20µm wide. Eyes about 12µm across.

Reproductive System. Female. Ovary 40-41µm (\bar{x} =41µm) long, 18-21µm (\bar{x} =20µm) wide. Vesicula resorbens 36-54µm (\bar{x} =45µm) across, wall 6-9µm thick. Seminal receptacle about 9-11µm across. Vagina with distinct lateral pocket.

Male. Anterior testes about 27-43µm (\bar{x} =35µm) long, 31-37µm (\bar{x} =34µm) wide. Posterior testes about 58-66µm (\bar{x} =62µm) long, 27-28µm (\bar{x} =28µm) wide. Seminal vesicle 43-45µm

(\bar{x} =44µm) long, 23-25µm (\bar{x} =24µm) wide. Copulatory bulb, 31-31µm (\bar{x} =31µm) long, 39-40µm (\bar{x} =40µm) wide, with ejaculatory sac. Prostate duct reservoirs parallel. Cirrus (based on 3 adult specimens (1 inverted, 2 everted) ex QMGL18618) 188-196µm (\bar{x} =191µm) long in total. Shaft, goblet-shaped, curved, medium/thick-walled, with distal region longer than length of introvert; proximal opening 43-45µm (\bar{x} =44µm) wide, with narrow rim. Introvert slightly curved, 12-13µm (13µm) wide at base, longer side 65-67µm (\bar{x} =66µm) long, shorter side 57-57µm (\bar{x} =57µm) long (i.e. introvert about 5 times longer than width of introvert base), with asymmetrical swelling i.e. wider on longer side, distal opening about 15µm wide.

Hosts. *Cherax dispar* Riek, 1951; *Cherax depressus* complex *sensu* Riek, 1951: Parastacidae.

Locality. Conondale Ra., QLD.

ETYMOLOGY

A noun in apposition, *yabba* means forest in the local Waka language of the Aboriginal people and refers to the type locality, the Conondale Ranges.

REMARKS

C. yabba is very close to *C. simulator* in general body form and the morphology of the cirrus. However, the cirrus of *C. yabba* has a shorter introvert and the ratio of the length of the tubular distal region of the shaft to the length of the introvert is never less than 1:1 compared to that for *C. simulator* which is clearly less than 1:1. Moreover the introvert swelling on the longer and shorter sides of the introvert are more equal in thickness than those of *C. simulator*.

***Craspedella* sp. 1**
(Fig. 5B)

MATERIAL EXAMINED

Ex *Cherax albidus* Clark, 1936 from Dwyers Ck, 2km SSW Mirrantawa, VIC (37°24'S; 142°23'E) 5/Oct/1991 Cannon L.R.G. & Sewell K.B. HW/Form/Hx, QMGL18420-18425 (WM), Form/Hx QMGL18426 (WM), HW/Form/deF QMGL18620 cirrus inverted (CP[1]).

REMARKS

The distinctiveness of the crayfish species *Cherax albidus*, the host of these worms, from *Cherax destructor* is uncertain (see Morrissey & Cassells, 1992). The worms appear close to *C. simulator* in general anatomy including the form

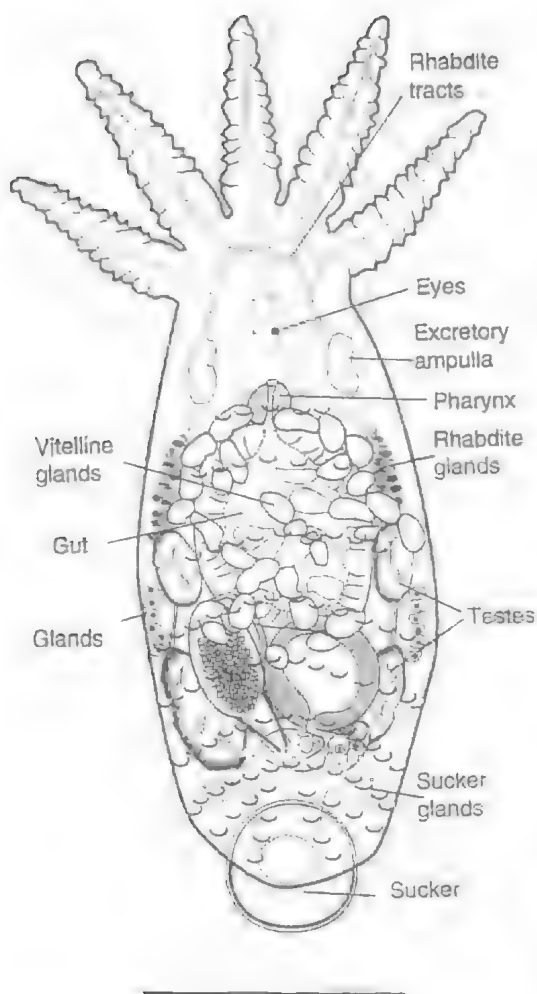


FIG. 6. *Heptacraspedella peratus* gen. et sp. nov. Holotype. Scale = 250µm.

of the transverse and posterior ridges, however, they show some slight differences in the shape of the cirrus which in the shaft at least (Fig. 5B) resembles that of *C. spenceri*. The worms may prove a further distinct species. The small number of specimens collected and the large geographical range of *C. destructor/albidus* makes us hesitant to erect a new species of *Craspedella* at this time.

Heptacraspedella gen nov.

DIAGNOSIS

Craspedellinae with seven dorsal transverse papillate ridges, and behind the last ridge, four short posterior papillate ridges consisting of raised

points radiating towards the posterior body margin. Excretory ampullae strongly coiled and elongate. Muscles about seminal vesicle and copulatory bulb relatively very strong. Distal vaginal sphincter not pronounced.

TYPE SPECIES

Heptacraspedella peratus sp. nov.

ETYMOLOGY

Greek, *hepta*, seven, a reference to the number of ridges or edges.

REMARKS

The number and form of the dorsal ridges are quite different from those of *Craspedella spenceri* and other new members of that genus. The host, *Euastacus*, is also of a different genus; *Craspedella* spp. have only been found on members of *Cherax*. Parenchymal gland cell bodies (?mucus glands) were observed positioned laterally between the anterior and posterior testes (Fig. 6).

Heptacraspedella peratus sp. nov.

(Figs 1B, 5C, 6, 7, 10B)

MATERIAL EXAMINED

HOLOTYPE: QMGL18403 (WM), ex *Euastacus bispinosus* from Jimmys Ck., Grampians, at picnic ground 6.5km WNW Mafeking, VIC (37°23'S; 142°34'E) 5/Oct/1991 Cannon L.R.G. & Sewell K.B. HW/Form/Hx.

PARATYPES: Same data as holotype, QMGL18404-18405 (WM), Form/H&E QMGL18406-18407 (LS[1,1]).

OTHER MATERIAL: Same data as holotype. QMGL18408-18419 (WM), HW/Form/deF QMGL18621 cirrus everted (CP[4], 9 adult (1 bent), 1 young specimen(s)).

DESCRIPTION

External. Body from posterior margin to tip of tentacles 848-870µm (\bar{x} =862µm), to eyes 565-580µm (\bar{x} =575µm) long and 290-304µm (\bar{x} =300µm) wide. Posterior disc 137-152µm (\bar{x} =142µm) in diameter; peduncle 72-72µm (\bar{x} =72µm) in diameter. Epidermis about 4µm high dorsally, about 5µm high ventrally.

General Anatomy. Pharynx 33-50µm (\bar{x} =40µm) long, 33-50µm (\bar{x} =40µm) wide. Gastrodermis about 35µm high. Excretory ampullae elongate 65-65µm (\bar{x} =65µm) long and 25-25µm (\bar{x} =25µm) wide. Eyes about 15µm across.

Reproductive System. Female. Ovary about 55µm across. Vesicula resorbiens 116-123µm

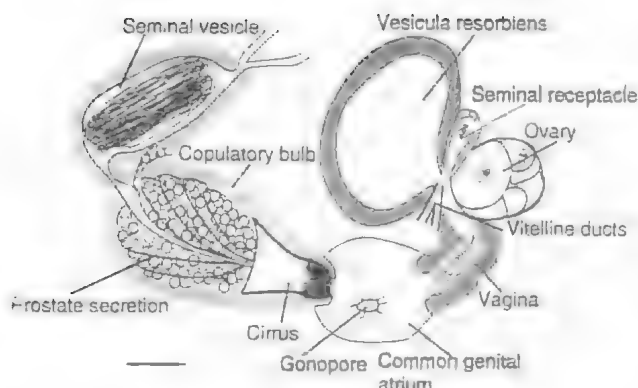


FIG. 7. Reproductive structures of *Heptacraspedella peratus* gen. et sp. nov. Scale = 50 μ m.

(\bar{x} =118 μ m) across, wall about 15 μ m thick, embedded in gut wall, not open to gut. Seminal receptacle at least 12 μ m long.

Male. Anterior testes about 70–80 μ m (\bar{x} =76 μ m) across. Posterior testes about 108–156 μ m (\bar{x} =131 μ m) long and 40–50 μ m (\bar{x} =44 μ m) wide. Seminal vesicle strongly muscled 58–101 μ m (\bar{x} =75 μ m) long, 43–45 μ m (\bar{x} =44 μ m) wide. Copulatory bulb 101–130 μ m (\bar{x} =118 μ m) long, 80–87 μ m (\bar{x} =82 μ m) wide, without ejaculatory sac. Prostate duct reservoirs oblique (except in most proximal region of bulb). Cirrus (based on 8 adult specimens (all everted) ex QMGL18621) 76–104 μ m (\bar{x} =93 μ m) long in total. Shaft cone-shaped, not curved, thick walled; proximal opening 51–89 μ m (\bar{x} =75 μ m) wide, with slightly thickened rim. Introvert 32–35 μ m (\bar{x} =33 μ m) wide at base, sides about equal length 38–42 μ m (\bar{x} =40 μ m) long (i.e. introvert slightly longer than width of introvert base), distal opening unable to be determined accurately due to lack of fully inverted specimens (about 10 μ m wide), with wide, near symmetrical swelling.

Hosts. *Euastacus bispinosus* Clark, 1941: Parastacidae.

Locality. Jimmys Ck., Grampians, VIC.

ETYMOLOGY

Latin, *peratus*, western/edge, referring to having a host species at the western most edge of the range of its genus (*Euastacus*).

Zygopella gen. nov.

DIAGNOSIS

Craspedellinae with a single transverse papillate ridge lacking lobes across the posterior body; and with a pair of pits behind it each defined dorsally by a horseshoe-shaped papillate ridge. Vagina musculature with distinct distal sphincter.

TYPE SPECIES

Zygopella pista sp. nov.

OTHER SPECIES

Zygopella deimata sp. nov.

Zygopella stenota sp. nov.

ETYMOLOGY

Greek, *zygon*, yoke and Greek (feminine), *pella*, cup, i.e. symmetrical cups.

REMARKS

The possession of only a single papillate ridge and, instead of 4 posterior ridges, a pair of pits each defined by a horseshoe-shaped papillate ridge, clearly distinguishes *Zygopella* from *Craspedella* and *Heptacraspedella*.

Zygopella pista sp. nov.

(Figs 1C,E,5D,8,9)

MATERIAL EXAMINED

HOLOTYPE: QMGL18326 (WM), ex *Cherax tenuimanus* from Margaret R., at water catchment weir, WA (33°57.0'S; 115°05.2'E) 23/Jan/1992 Cannon L.R.G. & Sewell K.B. HW/Form/Hx.

PARATYPES: Same data as holotype, QMGL18327 (WM), QMGL18328 (WM), Bouin/H&E QMGL18329–30 (LS[1,1], Bouin/H&E QMGL18331 (FS[3])).

OTHER MATERIAL: Same data as holotype, QMGL18332–63 (WM), Bouin/H&E QMGL18364 (LS[1]), QMGL18365 (LS[2]), QMGL18366 (LS[1]), QMGL18367 (LS[1]), QMGL18368 (LS[1]), HW/Form/dcF QMGL18622 cirrus everted (CP[5], 5 adult specimens); also ex *Cherax tenuimanus* from 'Margaret R. Marron Farm', 10km SE Margaret R., WA Australia (34°00.8'S; 115°09.5'E) 23/Jan/1992 Cannon L.R.G. & Sewell K.B. HW/Form/Hx QMGL18369–18373 (WM), Bouin/H&E QMGL18374 (FS[2]), QMGL18375 (LS[2]), Bouin/H&E QMGL18376–18380 (LS[1]).

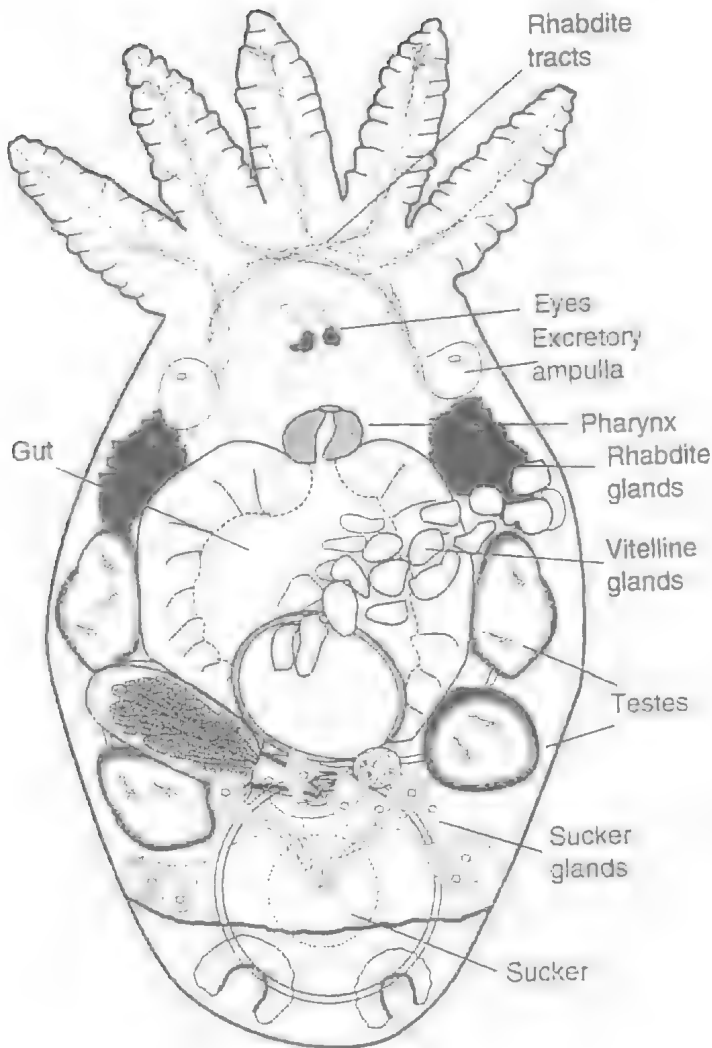


FIG. 8. *Zygopella pista* gen. & sp. nov. Holotype. Scale = 250µm.

DESCRIPTION

External. Body from posterior margin to tip of tentacles 667–884µm (\bar{x} =748µm), to eyes 457–616µm (\bar{x} =513µm) long, and 348–417µm (\bar{x} =378µm) wide. Posterior disc 137–150µm (\bar{x} =144µm) in diameter; peduncle 72–87µm (\bar{x} =78µm) in diameter. Epidermis about 2µm high dorsally and ventrally.

General Anatomy. Pharynx 38–50µm (\bar{x} =44µm) across, Gastrodermis about 45µm

high. Excretory ampullae 40–45µm (\bar{x} =42µm) across. Eyes about 15µm across with short, narrow pigment tails that descend ventrally.

Reproductive System. Female. Ovary about 47µm across. Vesicula resorbens 100–120µm (\bar{x} =107µm) across; wall about 3–5µm thick, embedded in gut wall, not open to gut. Seminal receptacle about 10µm long.

Male. Anterior testes about 73–87µm (\bar{x} =80µm) across. Posterior testes about 73–108µm (\bar{x} =85µm) across. Seminal vesicle 80–110µm (\bar{x} =99µm) long, 36–50µm (\bar{x} =43µm) wide, strongly muscled. Copulatory bulb 100–130µm (\bar{x} =119µm) long, 36–50µm (\bar{x} =44µm) wide; with ejaculatory sac. Prostate duct reservoirs oblique. Cirrus (based on 5 adult specimens (all everted) ex QMGL18622) 54–66µm (\bar{x} =61µm) long in total. Shaft, cone-shaped, curved, thin walled; proximal opening 25–29µm (\bar{x} =27µm) wide with narrow rim. Introvert 10–10µm (10µm) wide at base with junction between introvert and shaft oblique, longer side 20–22µm (\bar{x} =21µm) long, shorter side 16–17µm (\bar{x} =17µm) long (i.e. introvert about two times longer than width of base), with thin, asymmetrical swelling, i.e. wider on longer side of introvert, distal opening width not able to be determined accurately due to lack of fully inverted specimens (about 7µm wide).

Hosts. *Cherax tenuimanus* (Smith, 1912): Parastacidae.

Locality. Margaret R., WA (wild and in culture).

ETYMOLOGY

Greek, *pistos*, faithful and refers to the retention of this species with its host even when placed into culture, a situation which sees the external natural temnocephalid replaced with a translocated species (Cannon & Sewell, 1994).

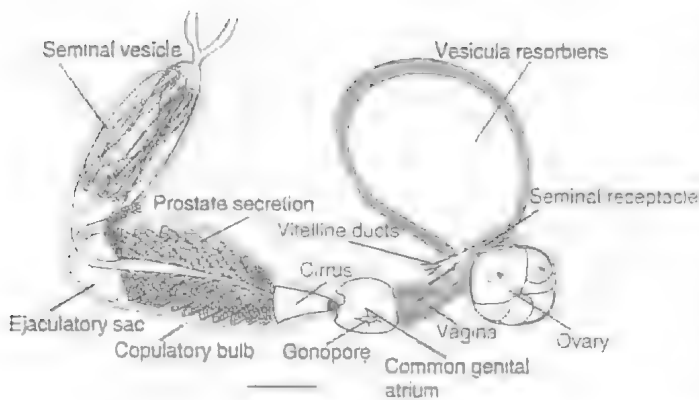


FIG. 9. Reproductive structures of *Zygopella pista* gen. et sp. nov. Scale = 50 μ m.

***Zygopella deimata* sp. nov.**
(Fig. 5E)

MATERIAL EXAMINED

HOLOTYPE: QMGL18381 (WM), ex *Cherax tenuimanus* from Inlet R., on South Western Highway to Walpole, WA (34°55.2'S; 116°34.2'E) 25/Jan/1992 Cannon L.R.G. & Sewell K.B. HW/Form/Hx.

PARATYPE: Same data as holotype, QMGL18428 (LS[2]).

OTHER MATERIAL: Same data as holotype, HW/Form/deF QMGL18623 cirrus everted (2 adult specimens).

DESCRIPTION

External. Body from posterior margin to tip of tentacles 792 μ m, to eyes 540 μ m long and 306 μ m wide. Posterior disc 122 μ m in diameter; peduncle 65 μ m in diameter. Epidermis about 2–3 μ m dorsally and ventrally.

General Anatomy. Pharynx 35 μ m long, 50 μ m wide; Gastrodermis about 60 μ m high. Excretory ampullae thick walled about 47 μ m across. Eyes about 12 μ m across.

Reproductive System. Female. Ovary 50 μ m long, 21 μ m wide. Vesicula resorbiens 144 μ m across, wall 21 μ m thick. Vagina with pronounced distal sphincter and very prominent proximal longitudinal folds.

Male. Anterior testes about 83 μ m across. Posterior testes about 90 μ m across. Seminal vesicle 90 μ m long, 63 μ m wide, strongly muscular. Copulatory bulb 100 μ m long, 63 μ m wide, without ejaculatory sac. Prostate duct reservoirs oblique. Cirrus (based on 2 everted specimens ex QMGL18623) 119–121 μ m (\bar{x} =120 μ m) long in total. Shaft cone-shaped, not curved, thick-

walled; proximal opening 82–86 μ m (\bar{x} =84 μ m) wide with thickened rim. Introvert 16–17 μ m (\bar{x} =17 μ m) wide at base, both sides about 34 μ m long (i.e. introvert about two times longer than width of base), distal opening unable to be determined accurately due to lack of fully inverted specimens, with near symmetrical swelling. Proximal spines very large, with at least three large dagger-shaped spines, about 30 μ m long positioned centrally and apparently attached to introvert base.

Hosts: *C. tenuimanus* (Smith, 1912): Parastacidae.

Locality: Inlet R., WA.

ETYMOLOGY

Greek, *deimatos*, a fearful thing, referring to the robust nature of the cirrus and its spines.

REMARKS

Only a few specimens were collected. However, the species is distinct, as the cirrus is large and quite unlike the modest cone found in *Z. pista*.

***Zygopella stenota* sp. nov.**
(Figs 1D, 5F)

MATERIAL EXAMINED

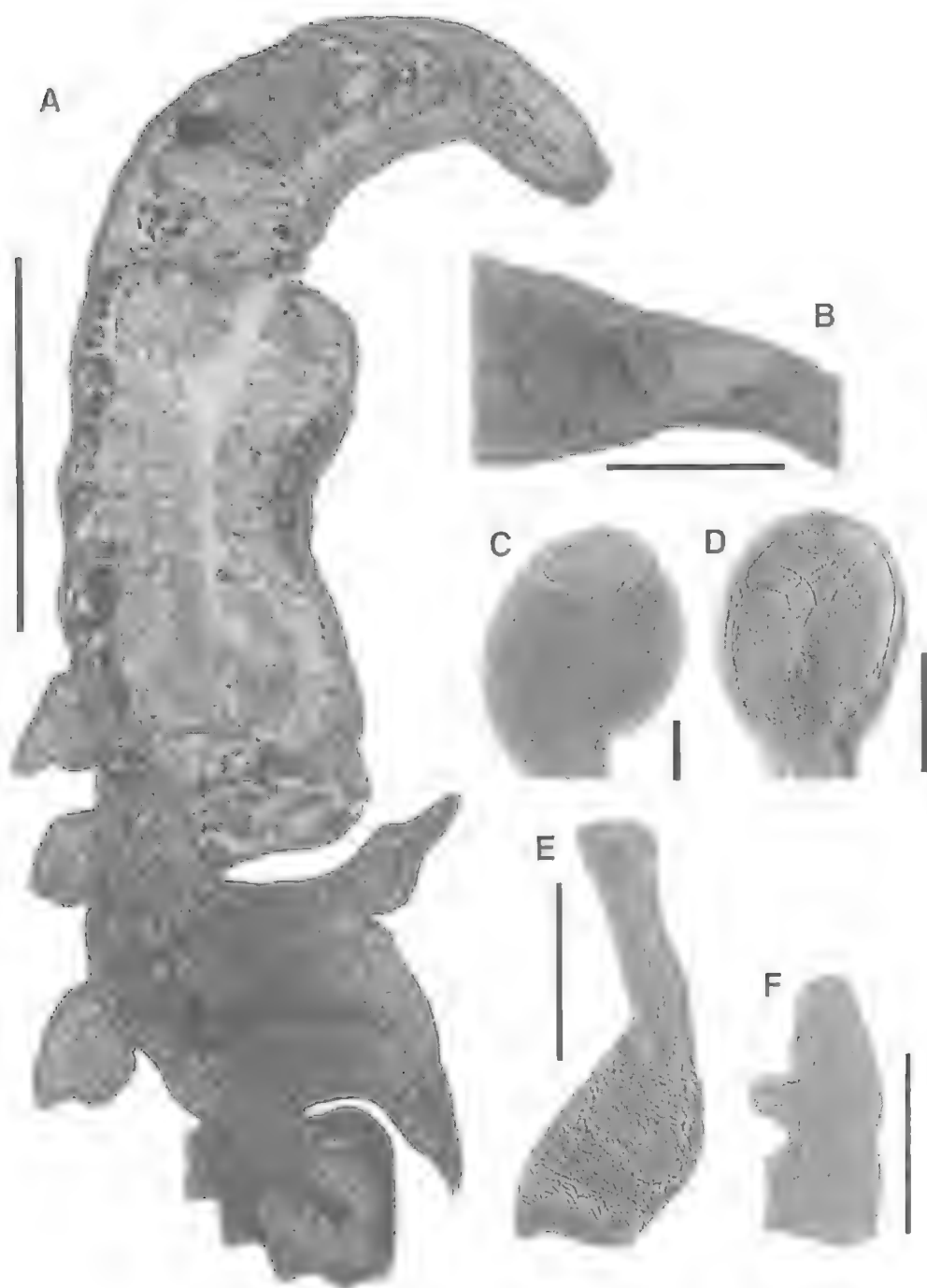
HOLOTYPE: QMGL18382 (WM), ex *Cherax c.f. quinquicarinalis* from Inlet R., on South Western Highway to Walpole, WA (34°55.2'S; 116°34.2'E) 25/Jan/1992 Cannon L.R.G. & Sewell K.B. Bouin/Hx.

PARATYPES: Same data as holotype, QMGL18383–18384 (WM), Bouin/H&E QMGL18385–18386 (LS[1,1]).

OTHER MATERIAL: Same data as holotype, QMGL18387–18389 (WM), Bouin/deF QMGL18624 (cirrus inverted (CP[2], 2 adult specimens), QMGL18625 cirrus everted (CP[6], 6 adult specimens): ex *Cherax tenuimanus* from Inlet R., on South Western Highway to Walpole, WA (34°55.2'S; 116°34.2'E) 25/Jan/1992 Cannon L.R.G. & Sewell K.B. HW/Form/Hx QMGL18390–18392 (WM), QMGL18427 HW/Form/H&E (LS[1]); ex *Cherax c.f. bicarinatus* from Deep R. tributary, circa 4 km N Mt. Pingerup, WA (34°50.4'S; 116°32.4'E) 25/Jan/1992 Cannon L.R.G. & Sewell K.B. HW/Form/Hx QMGL18393–18402 (WM).

DESCRIPTION

External. Body from posterior margin to tip of tentacles 476–570 μ m (\bar{x} =515 μ m), to eyes 335–



407 μm (\bar{x} =356 μm) long, and 251–272 μm (\bar{x} =261 μm) wide. Posterior disc 103–122 μm (\bar{x} =111 μm) in diameter; peduncle 44–63 μm (\bar{x} =53 μm) in diameter. Tentacles with very rugose crenulations.

General Anatomy. Pharynx 18–25 μm (\bar{x} =22 μm) long, 25–37 μm (\bar{x} =31 μm) wide, Gastrodermis about 35–44 μm high. Excretory ampullae 28–40 μm across. Eyes about 9 μm across.

Reproductive System. Female. Ovary about 25 μm across. Vesicula resorbiens kidney-shaped 63–96 μm (\bar{x} =82 μm) long, 43–59 (\bar{x} =51 μm) wide, walls about 8 μm thick. Seminal receptacle about 10 μm long.

Male. Anterior testes about 70–100 μm (\bar{x} =86 μm) long, 37–49 μm (\bar{x} =42 μm) wide. Posterior testes about 70–94 μm (\bar{x} =82 μm) long, 44–57 μm (\bar{x} =50 μm) wide. Seminal vesicle 59–71 μm (\bar{x} =65 μm) long, 36–45 μm (\bar{x} =41 μm) wide, strongly muscled, it and copulatory bulb show a distinct semi-spiral arrangement of muscles. Copulatory bulb 57–65 μm (\bar{x} =61 μm) long, 33–39 μm (\bar{x} =36 μm) wide, with accessory sac. Prostate duct reservoirs parallel. Cirrus (based on 8 adult specimens except measurements of the width of the distal introvert based on two inverted specimens ex QMGL18624 and 18625) 38–47 μm (\bar{x} =43 μm) long in total. Shaft, cone-shaped, curved, thin-walled; proximal opening 15–19 μm (\bar{x} =16 μm) wide with narrow rim. Introvert 3–4 μm (\bar{x} =3 μm) wide at base, both sides 6–8 μm (\bar{x} =7 μm) long (i.e. introvert about 2.5 times longer than width of base), distal opening 3–4 μm (\bar{x} =4 μm) with narrow, near symmetrical swelling.

Hosts. *Cherax* c.f. *bicarinatus* (Gray, 1845); *C.* c.f. *quinquicarinatus* (Gray, 1845); *C. tenuimanus* (Smith, 1912); Parastacidae.

Locality. Deep R. and Inlet R., WA.

ETYMOLOGY

Greek, *stenotes*, narrow referring to the narrowness of the cirrus introvert.

REMARKS

Evidently quite close to the type species *C. pista*, but with a characteristically narrow cirrus. The seminal vesicle and copulatory bulb show a distinct semi-spiral arrangement of muscles. The tentacles of all the specimens we observed had extremely rugose crenulations independent of fixation, compared to the other species (Fig. 1D).

DISCUSSION

For over 100 years *Craspedella spenceri* has been the only temnocephalan species recognised with papillate posterior dorsal ridges. Other species have possibly been confused with it (e.g., Cannon & Jennings, 1987). The small size and delicate nature of these worms, and their cryptic habitat in the branchial chamber, has evidently ensured the richness of the fauna was overlooked.

The distinctive facies of this group of genera with their well developed papillate ridges and crenulate tentacles presumably relate to their habitat, the branchial chamber. The relationship of form, function and habitat are the subject of continuing detailed studies by one of us (KBS) on *C. pedum* from the 'redclaw' *Cherax quadricarinatus*.

We have recognised the Craspedellinae and include in it 3 genera comprising a total of 11 species of temnocephalans, all from the branchial chamber of crayfish and characterised by possession of crenulate tentacles and one or more transverse dorsal papillate ridges. The morphological differences between this group and the remainder of the Temnocephalidae are insufficient in our opinion, to justify the re-erection of the family Craspedellidae created by Baer (1931). In this we concur with Bresslau & Reisinger (1933), but the similar facies of so many taxa indicates a sub-family rank is appropriate.

As with many small worms, fixation to provide consistent form for comparison is difficult. Cold fixation usually ensures considerable distortion. The hot water treatment was effective in producing uniform fixation of extended worms suitable

FIG. 10. Light photomicrographs: A, *Craspedella spenceri*, Longitudinal section through centre of specimen QMGL18490 showing weak pharynx and 3 prominent lamellae. Scale = 200 μm . B, longitudinal section through anterior end of *Heptacraspedella peratus* gen. & sp. nov. showing large, elongate excretory ampullae. Scale = 100 μm . C, copulatory bulb of live *Craspedella pedum* sp. nov. showing 'reduced' ejaculatory sac contained within the musculature of the bulb. Scale = 50 μm . D, copulatory bulb from wholemount of *Craspedella shorri* sp. nov. Note absence of ejaculatory sac and baccate pattern formed by the prostate duct reservoirs. Scale = 50 μm . E, vagina of *Craspedella spenceri* cleared in de Faure's medium to reveal shape of vaginal cavity. Scale = 50 μm . F, vagina of *Craspedella simulator* sp. nov. cleared in de Faure's medium to reveal shape of vaginal cavity and prominent lateral pocket. Scale = 50 μm .

for wholemounts, although it could be considered only 'adequate' for preparation of specimens for sectioning. Similarly the quality of the SEM fixation for this study was only adequate and this prompted the study of Sewell & Cannon (1995) to determine an optimum fixation regime for the SEM of *Craspedella pedum*.

In the wild, *C. spenceri* and *C. simulator* occurred together in the branchial chamber of 2 species of *Cherax*. Co-occurrence was also observed with *Z. stenota* and *Z. dlemata* on *C. tenuimanus*. It is of ecological interest that different yet closely related species of Craspedellinae co-inhabit the branchial chamber microhabitat of a single crayfish host. In particular, questions are raised as to how such a niche is partitioned.

The strong association of the Craspedellinae with *Cherax* spp. crayfish raises issues of host phylogeny, taxonomy and biogeography e.g. the occurrence of *Zygopella* spp. on *Cherax* of Western Australia and not *Craspedella* spp. which are confined to *Cherax* of eastern Australia. These questions can hopefully be addressed after analyses of the distribution of many potential new species of temnocephalan species collected from Australian *Cherax* spp. in the course of fieldwork associated with the present study. Evidence for a high diversity of temnocephalan species associated with *Euastacus* was presented by Cannon & Sewell (1994).

It is perhaps not surprising that distinctive *Heptacraspedella* occurs on the crayfish *Euastacus*. The two crayfish genera *Cherax* and *Euastacus* are distinct and show considerable differences in habitat and life style. *Cherax* are commonly found in slower, lowland or coastal streams, often (but not always) with open canopy above: *Euastacus* prefers fast, and often high country, streams with a closed forest canopy. In examination of many species of *Euastacus* from Cape York to the Grampians this was the only occasion on which gill temnocephalans (with the exception of *Didymorchis* spp. which were not included in this study) were detected. Most often *Euastacus* specimens were collected by hand from the edges of streams and though many were mature and were host to external temnocephalans the crayfish were usually small. If large specimens of *Euastacus* can be obtained from traps other species of gill dwelling temnocephalans may be found.

Our species descriptions rely more heavily on descriptions of the cirrus than previous recent publications on Australian Temnocephalida (e.g., Hickman, 1967; Cannon, 1991, 1993). The cirrus

introvert is a reliable character to separate species because it is the cirrus structure which is first formed in juveniles and its dimensions, unlike those of the cirrus shaft, remain constant as the worms age (unpublished observations). The use of Faure's medium allows more accurate detail of the morphology of the cirrus than has been available in the past. We did not base the separation of species on the dimensions and arrangement of the introvert spines, as these characters could not always reliably be determined, particularly from specimens fixed prior to placement in de Faure's medium. Furthermore, the introvert swelling was often difficult to observe in specimens which were placed live into de Faure's medium as it appeared to clear more than for specimens fixed previously. Moreover, when the cirrus was everted, the swelling was obscured. Therefore, we excluded the introvert swelling from our measurements of the cirrus.

The original description of *Craspedella spenceri* Haswell, 1893 was based largely on the lamellate, papillate frills of the species. We were able to clearly recognise this species with large lamellations and prominent lobes tipped with papillae, which we have called *C. spenceri*. These features were observed even on small juvenile worms. However, the cirrus figured by Haswell (1893) does not conform to that which we observed for this species. The goblet shape of the shaft and the narrow width of the introvert suggest that this cirrus belongs instead to *C. simulator* which we observed to co-inhabit the branchial chamber of the crayfish *Cherax destructor* over a wide geographical area. Furthermore, Haswell (1893) apparently figured the cirrus erroneously as he drew the teeth of the inverted introvert as pointing proximally not distally as we observed for all the species we studied. Similarly, we did not observe the ejaculatory sac to be discrete as figured by Haswell (1893). In all species of Craspedellinae observed to possess an ejaculatory sac, it is 'reduced' i.e. contained within the copulatory bulb musculature. In the shadow of this uncertainty, we chose to retain the name *C. spenceri* to describe the worm with large lamellations. However, additional exceptional circumstances exist in that the crayfish host recorded by Haswell (1893) cannot be reliably identified, and the localities he provided are vague and wide ranging. Therefore, we erect a neotype for *C. spenceri* from what is in our opinion the host most likely to have been collected by Haswell (1893) (i.e. *Cherax destructor*), from a locality approximately at the middle of the geographical range of

the crayfish (John Short, personal communication).

Our field collecting has not been exhaustive. We predict that with further field examination of crayfish hosts, the branchial chamber habitat of Australian crayfish will reveal a greater diversity of the Craspedellinae. Moreover, there is evidence that the group also occurs outside Australia. A undescribed, putative species of *Craspedella* with a cirrus clearly different to that of any of the species described in the present study, collected from the crayfish *Cherax communis* Holthuis, 1949 from Papua New Guinea, is held in the private collection of Dr Boris Joffe of the Zoological Institute, St. Petersburg, Russia (B. Joffe, personal communication).

ACKNOWLEDGEMENTS

The contribution of KBS to this study forms part of a PhD within the Department of Parasitology and Anatomical Sciences, the University of Queensland.

First, we wish to thank the Australian Biological Resources Study for a grant (87/5909) to LRGC which funded the study. We thank museum staff of the state museums of New South Wales, Victoria and Western Australia, who assisted greatly in appraising collections and records of crayfish to assist in locating suitable collecting sites, most notably Dr Penny Baerents, Australian Museum, Dr Gary Poore, Museum of Victoria and Dr Gary Morgan, Western Australian Museum. We are indebted to Dr Don Horning from the McLeay Museum, University of Sydney for his attempts to locate specimens or data pertinent to Haswell's collections. Dr Pierre Horwitz (Curtin University) and Dr Brenden Knott (University of WA) provided valuable assistance with WA crayfish localities and habitats and Dr Louis Evans (Edith Cowan University) provided data of Western Australian temnocephalans. Mr Wolfgang Zeidler, South Australian Museum and Dr Ian Beveridge, University of Melbourne kindly provided data and worms respectively. Mr John Short of the Crustacean Section of the Queensland Museum (QM) was extremely helpful in the identification of crayfish and with literature on the hosts. Furthermore, we would like to thank Christine Lee and Zeinah Khalil (QM) for their intelligent and dedicated attention to specimen preparation in the laboratory. Dr Boris Joffe of the Zoological Institute, St. Petersburg, Russia, enlightened us to the value of de Faure's preparations of the cirrus and provided

invaluable expert advice. We thank officers of the National Parks and Forestry in all states for assistance with locating crayfish habitats.

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A PERMINERALISED CUPULATE FRUCTIFICATION FROM QUEENSLAND

H. TREVOR CLIFFORD

Clifford, H.T. 1995 12 01: A permineralized cupulate fructification from Queensland. *Memoirs of the Queensland Museum* 38(2):419-427. Brisbane ISSN 0079-8835.

Cupules containing 2-8 ovules are described as *Dawesia cupulata* gen. et sp. nov., a taxon of uncertain affinities. The cupules and single dispersed ovules are embedded in permineralised peat boulders of Jurassic age which occur surficially at Miles but are incorporated in sediments of the Kumbarella Beds at Chinchilla. □ Jurassic, fructification, *Dawesia cupulata*.

H. Trevor Clifford, Queensland Museum, PO Box 3300, South Brisbane, Queensland, 4101, Australia; 1 August 1995.

Permineralised peat known to the lapidarists of southeastern Queensland as "forest-floor" is rich in plant material amongst which, leaves, stems and ovules are conspicuous. The preservation of tissues in the peat is poor, except for that of the wood and the ovules, the cell structure of whose integuments is discernible. Abundant impressions of a *Cladophlebis* sp. are also present

on some surfaces. Although most ovules are solitary they sometimes occur in clusters which are enclosed in cupules (Figs 1,2). The earliest known collection of a cupule is that of E.O Marks, who early this century, found a specimen in the Chinchilla district. A photograph of the cupule, labelled "Gymnospermous seed capsule" has been published by Hill et al. (1966).

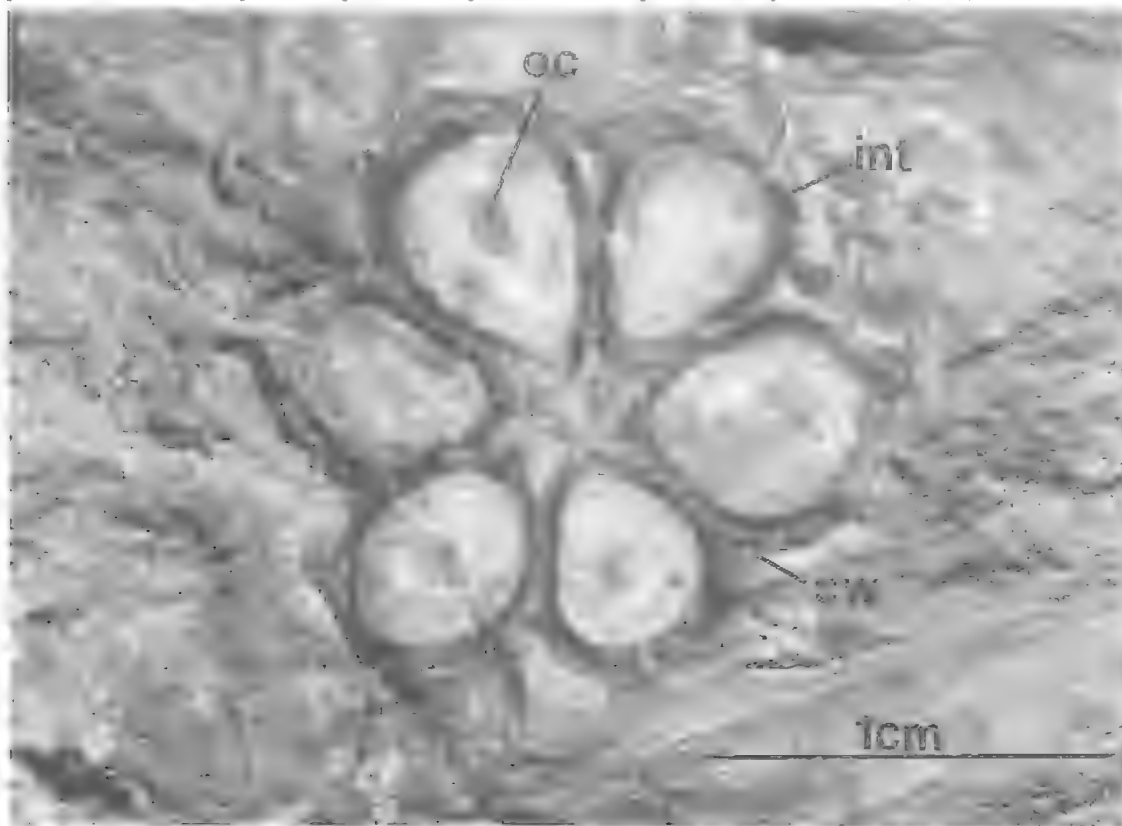


FIG.1. *Dawesia cupulata* gen. et sp. nov., holotype, QMF32157, rosette of ovules, exposed on the surface of a boulder of "forest floor"; collected at Miles: oc, ovule cavity; cw, cupule wall; int, integument.

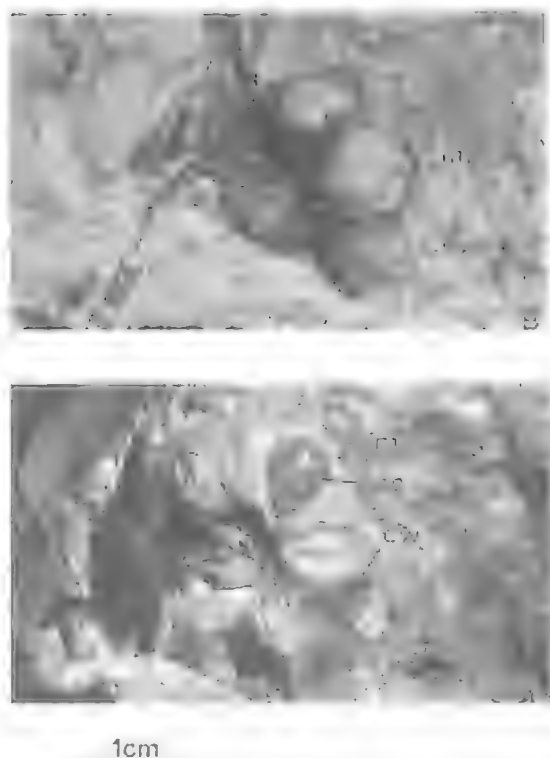


FIG.2. *Dawesia cupulata* gen. et sp. nov. A-B, Cupules of paratypes exposed on the surfaces of two "forest floor" boulders collected from along Rocky Creek near Chinchilla. A, QMF32185. B, QMF32184. Oc, ovule cavity; int, integument; cw, cupule wall; cb, cupule base; o, ovule.

ABBREVIATIONS USED: QM, Queensland Museum; GSQ, Queensland Geological Survey.

STRATIGRAPHY

The source of most "forest floor" specimens is uncertain because all have been collected as surficial boulders from hillsides or stream beds. However, at least some of those boulders which show little evidence of abrasion and have been collected from along the bed of Rocky Creek, Chinchilla almost certainly derive from a lens of "forest floor", incorporated in a single sandstone bed which is exposed in the low cliffs forming the right-bank of the Creek (26°34'S, 150°36'E) 100-200m upstream from the collecting site.

The strata which are exposed in the cliffs are members of the Kumbarilla Beds a series of fine to coarse grained sediments and thin bands of coal, for the most part, laid down in stream, deltaic and lake environments (Reiser, 1971).

Lenses of permineralized peat are also present. The Beds are about 600m thick and dip gently to the south. They range in age from Late Middle Jurassic to earliest Cretaceous (Day et al., 1983) or to Upper Cretaceous (Exon, 1976).

The only in situ "forest floor" encountered in this study was a lens about 2m long and about 15cm thick which being incorporated in a sandstone bed that occurs in the upper portion of the Kumbarilla Beds is close to the Jurassic-Cretaceous boundary. None-the-less the *Cladophlebis* leaf impressions associated with the cupules derive from a typically Jurassic taxon (J. Rigby, pers. comm.) thereby confirming the pre-Cretaceous age of the "forest floor". As the ovules in the permineralized peat are not compressed it must have been silicified before being deeply buried. The source of silicification is not known but from an examination of thin sections of "forest floor" it is evident that at least two phases of silicification have occurred (A. Cook, pers. comm.).

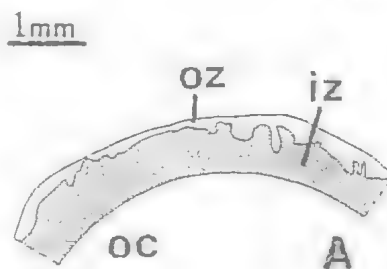
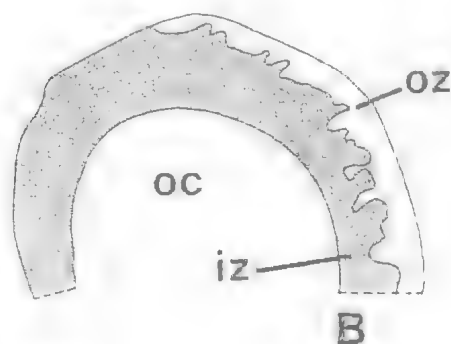


FIG.3. A-B, Integument of *Dawesia cupulata* gen. et sp. nov. A, QMF31911, upper portion of integument of central ovule in Fig.10C viewed in reflected light. B, QMF32160, portion of an integument viewed in transmitted light. oz, outer zone; iz, inner zone; oc, ovule cavity.

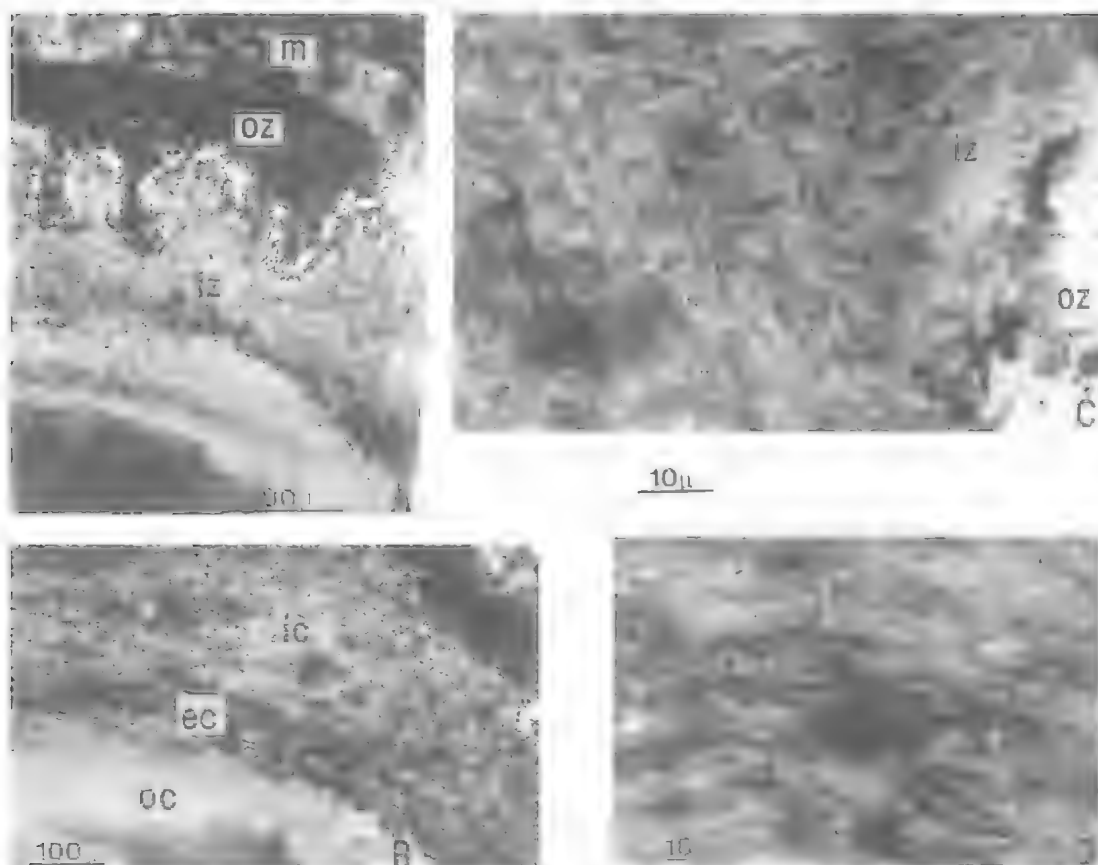


FIG. 4. *Dawesia cupulata* gen. et sp. nov. A-D, QMF32161, transverse sections of integument, viewed in transmitted light. A, Integument and ovule cavity. B, Inner zone of integument and ovule cavity. C, Isodiametric cells of integument. D, elongated cells of integument close to ovule cavity: m, investing matrix; oz, outer zone; iz, inner zone; oc, ovule cavity filled with chalcedony; ec, elongated cells; ic, isodiametric cells.

SYSTEMATIC PALAEOBOTANY

Division INCERTAE SEDIS
Form Order DAWESIALES ord. nov.
Form Family DAWESIACEAE fam. nov.
Dawesia gen. nov.

DIAGNOSIS

As for the only presently known species.

TYPE SPECIES

Dawesia cupulata sp. nov.

DIAGNOSIS

Ovuliferous organs consisting of cupules, each bearing 2-8 turbinate ovules on its inner surface, micropyle not extended and the integument membranous throughout, lacking vascular tissue and

resin bodies; cupules pedicellate and possibly occurring in pairs.

ETYMOLOGY

For Graham Wallace Dawes, the collector of QMF32157. Latin *cupulata*, like a cup.

Dawesia cupulata sp. nov.

Figs 1-10

DIAGNOSIS

Cupule hemispherical, c. 16 mm in diameter, the outer surface ribbed; ovules turbinate, 8-9 mm long and 7 mm in diameter.

MATERIAL EXAMINED

HOLOTYPE: QMF32157, Miles, Queensland 26°35'S, 150°16'E.

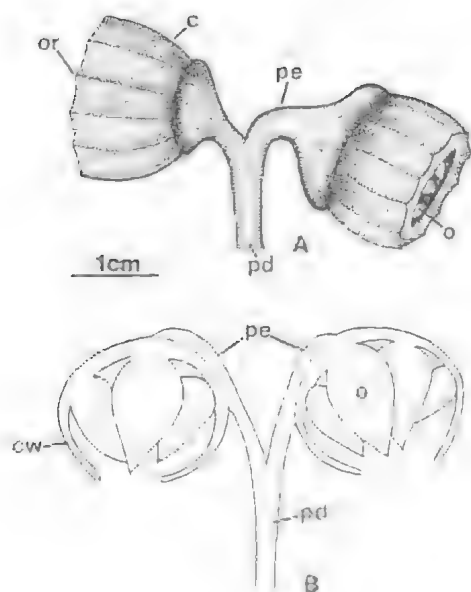


FIG. 5. *Dawesia cupulata* gen. et sp. nov. A, Reconstruction of a pair of cupules. B, Diagrammatic longitudinal section of cupule pair illustrated in Fig 5A. Though illustrated as occurring in pairs the cupules may be solitary. C, cupule; cw, cupule wall; o, ovule; pe, pedicel; pd, peduncle; or, ornamental rib.

PARATYPES: QMF32156, QMF31911, GSQF141; Chinchilla, Queensland 26°134'S, 150°36'E.

DESCRIPTION

Ovule morphology. Mature ovules, as recognised by their having been shed from the cupule, are turbinate and 8-9mm long, with maximum width c. 7mm one third of the distance from the broad chalazal to the narrow micropylar end. The radial symmetry of the ovules may be modified by compression resulting from contact with adjacent ovules. The ovules arise from the basal region of the inner surface of the cupule and they lack micropylar beaks.

The integument is unvascularised and has no internal glands. It is about 1mm thick and is usually differentiated into two zones which are separated by an irregular boundary. The outer and usually narrower of the two zones, when present, is light- to pale-brown whereas the inner is brown to dark-brown. The zones are evident in both transverse (Fig. 10A-B) and longitudinal (Fig. 10C) sections and are clearly discernable in both transmitted (Fig. 4A) and reflected light (Fig.

10A-C). Although the boundary between the zones is quite definite it has no regular pattern and is not associated with any constant differences in cell-type. It is apparently an artifact that arose during the process of mineralization. Support for this interpretation of the origin of the zonation is afforded by the inconstancy of the widths of the two zones and the complete absence from some integuments, or parts thereof, of the pale outer zone (Fig. 3B).

The cells of the integument are either straight-walled and isodiametric with diameters of 25-35µm (Fig. 4C) or are elongated with slightly curved walls (Fig. 4B,D). The elongated cells, which may be up to three times longer than broad with diameters similar to those of the isodiametric cells, occur towards the inner side or the base of the integument. The long axes of the elongated cells have no consistent orientation but are mostly disposed obliquely or at right angles to the long axis of the ovule. The cells lining the micropylar canal do not differ markedly from the adjacent cells of the integument.

The shapes of the epidermal cells of the integument are unclear and no stomates have been observed. Furthermore, no megaspores, megaspore walls or gametophytes have been observed. The ovule cavities are filled completely with chalcedony.

Cupules. The ovules are borne in pedicellate cupules. The pedicels are possibly paired and are attached laterally close to the bases of the cupules (Figs 5A-B). As seen in vertical section the walls of the cupule completely embrace the ovules and are thinner on their sides than bases. Each cupule contains up to eight ovules which arise near to the base from its inner surface (Fig. 5B). A fully mature 6-8 ovuled cupule has a diameter of about 16mm. The upper surface of the cupule is ribbed (Figs 5A, 10A,B).

The epidermal cells of the outer surface of the cupule illustrated in Fig. 2B are of two types. The majority are square to rectangular in outline with slightly curved anticlinal walls. As seen from above the surfaces of the epidermal cells are pitted or finely grooved. The remaining cells are arranged in rings of 5-6 and disposed around apertures which presumably lead to sunken stomates (Fig. 6).

The above description of the cupule morphology derives from three sources.

1. *Partially exposed ovules.* The beautiful rosette of ovules which first directed attention to *Dawesia cupulata* is exposed on the surface of a boulder (Fig. 1). The cupule which is here re-

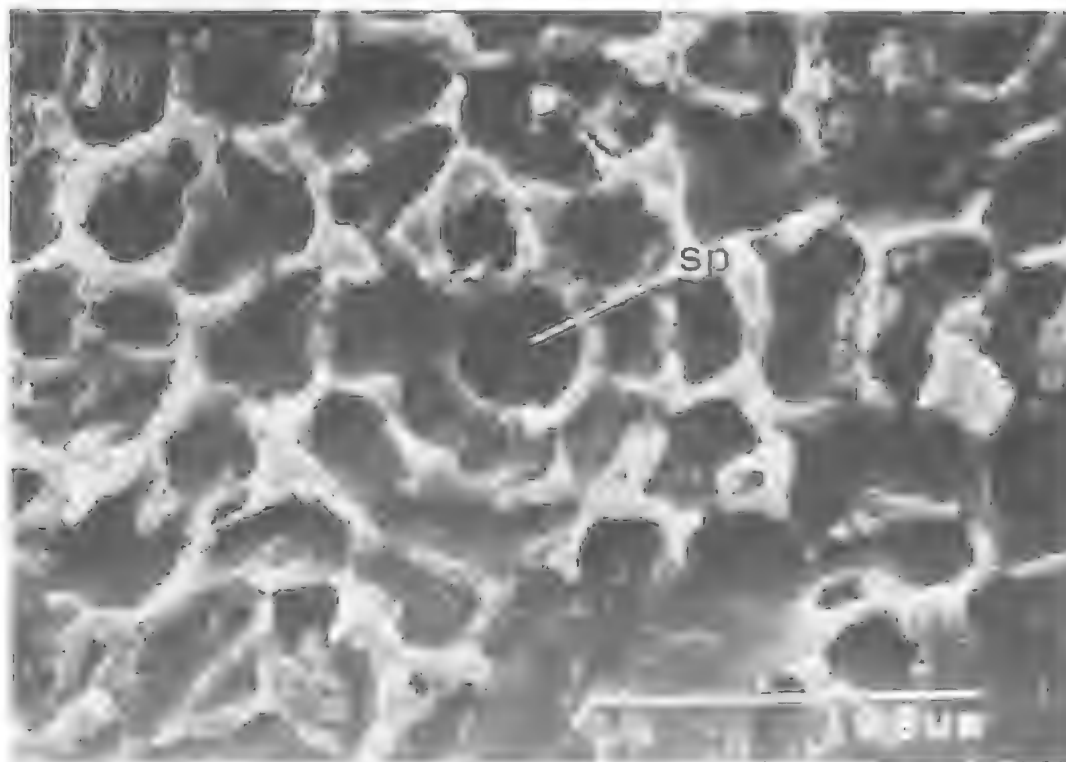


FIG. 6. *Dawesia cupulata* gen. et sp. nov. Epidermal cells as revealed in an electron micrograph of latex mould taken from the central area of the outer surface of the cupule illustrated in Fig. 2B: sp, stomatal pore.

vealed in transverse section is represented only by fragments of its wall. There is no clear indication of a central axis at the centre of the rosette suggesting the cupule is not peltate, as is confirmed by longitudinal sections. The two other clusters of ovules (Fig. 2) are revealed through the eroded bases of their cupules whose slight asymmetry is ascribed to the lateral attachment of their pedicels.

2. *Parallel sections.* The outlines of a partial cupule (Figs 7,8) and its enclosed ovules are exposed on the four surfaces of two adjacent slabs, cut from the same boulder as that with the rosette on its surface.

Using a common margin of the slabs as a reference line and allowing both for the differences in slab thickness and the width of the saw-cut a section of the cupule was constructed as it would appear at right angles to the exposed surfaces (Fig. 9). The dispositions of the ovules in this reconstructed section confirm they were borne in a cupule. The lack of continuity of the right hand wall of the cupule and the separation of the ovules suggests that considerable decomposition had taken place before preservation was achieved.

3. *Single sections.* Three additional cupule outlines are available. Using ovule shape as the determining criterion two of the sections are regarded as transverse and the third as longitudinal.

(a) *Transverse sections.* Because the outlines of the ovules are circular to elliptical with widths near to the maximum observed it is assumed both cupules have been cut across transversely and near to their bases (Figs 10A-B, 11A-B).

The cupule walls are thin (Figs 10B, 11B) and their outer surfaces are ornamented with small projections which are interpreted as superficial ridges seen in section.

(b) *Longitudinal section.* Because the outlines of its ovules are turbinate it is assumed the cupule has been cut longitudinally an opinion supported by the outline of the central of the three ovules whose integument is uniformly wide except where interrupted by the micropylar canal (Figs 10C, 11C). As expected where ovules are arranged in a circle the micropylar canals of the adjacent ovules are not visible on the exposed surface but can be seen through their integuments by focusing down into the almost transparent investing matrix.

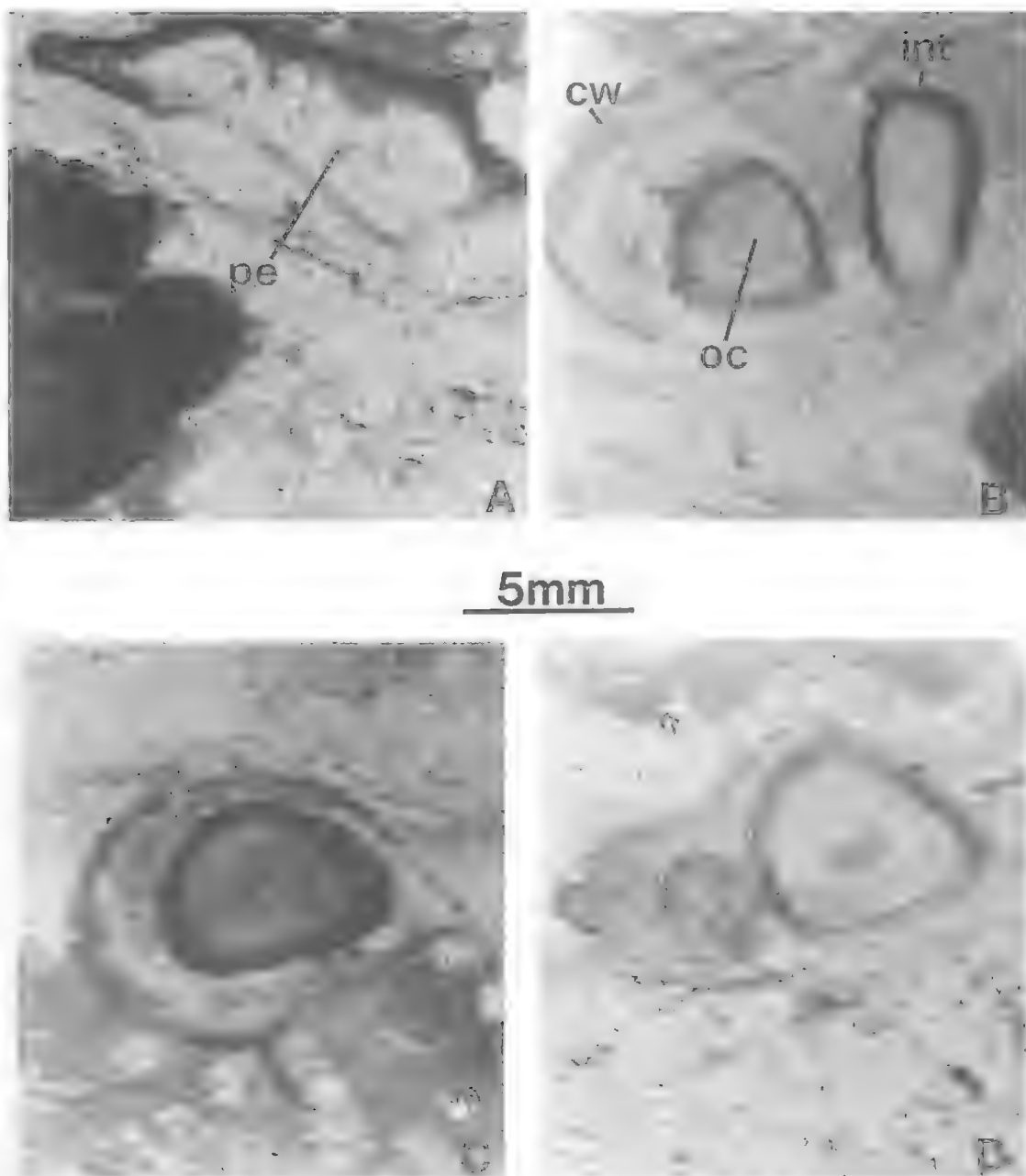


FIG. 7 *Dawesia cupulata* gen. et sp. nov. A-D, sections of an incomplete cupule of as exposed on the four planes resulting from the cutting of two parallel slabs from the boulder that includes the holotype. A-B, QMF32159a. C-D, QMF32159b: pe, pedicel; int, integument; oc, ovule cavity; cw, cupule wall.

The cupule wall completely embraces the ovules and is quite thin except at the base where it is attached to the pedicel. Unfortunately no tissues are preserved in this area but it appears that at least part of the apparent thickness of the cupule base may result from separation of the

outer epidermis from the surface of the cupule. In the right-hand side of this space a small rock fragment has been incorporated.

In this plane of section no surface ornament is present as would follow if the projections seen in the transverse sections are those of superficial

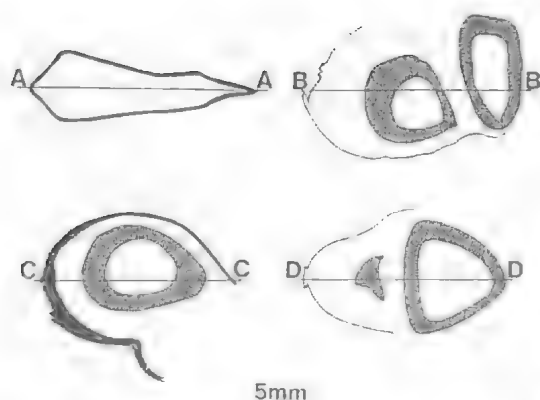


FIG. 8. A-D. As for Fig. 7. A, Pedicel of cupule. B-D, transverse sections of cupule.

ornamental ridges radiating from the base of the cupule.

Neither of the elliptical structures close to the apex of the ovule on the right-hand side of the cupule is regarded as associated with that structure.

The two cupules of which one is exposed in longitudinal section (Fig. 10C) and the other in transverse section (Fig. 10B) occur in close proximity on the facing surfaces produced by a single saw-cut. Though no organic connection between the two cupules has been established it has been assumed their close association indicates that the cupules occur in pairs. The manner of arrangement of these pairs into infructescences is not known.

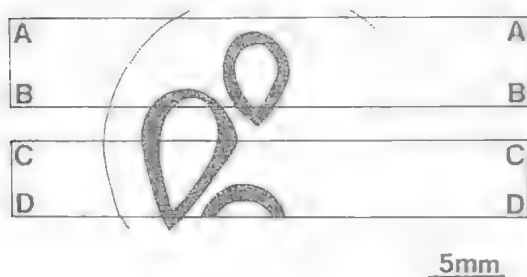


FIG. 9. *Dawesia cupulata* gen. et sp. nov., longitudinal section of a cupule reconstructed from the four transsects marked on the sections illustrated in Fig. 8.

DISCUSSION

The cupules of *Dawesia cupulata* are of particular interest for being permineralised and uncrushed their gross morphology can be reconstructed with reasonable certainty. Nonetheless, due to their poor state of preservation and lack of associated foliage the taxonomic affinities of the genus are unclear. The protection of ovules within a cupule is a feature that has evolved on several occasions and so is of little value for defining higher level taxa. Therefore, in

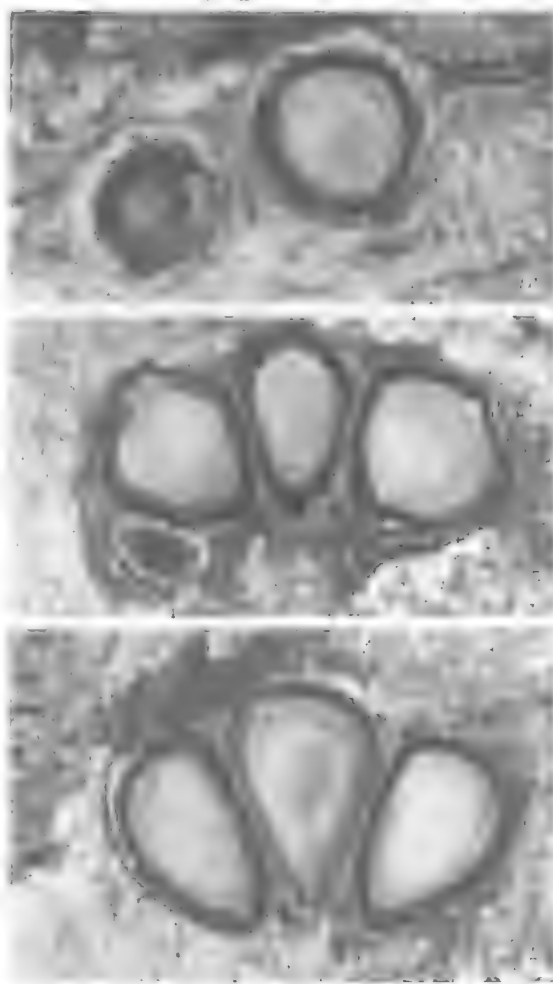


FIG. 10. *Dawesia cupulata* gen. et sp. nov. A-C, sections exposed on the surfaces of slabs cut from the boulder that includes the holotype. A, QMF32186, transverse section of a 2-ovulate cupule. B, QMF32156, transverse section of a >3-ovulate cupule. C, QMF31911, longitudinal section of >3-ovulate cupule with the central ovule cut in the median.

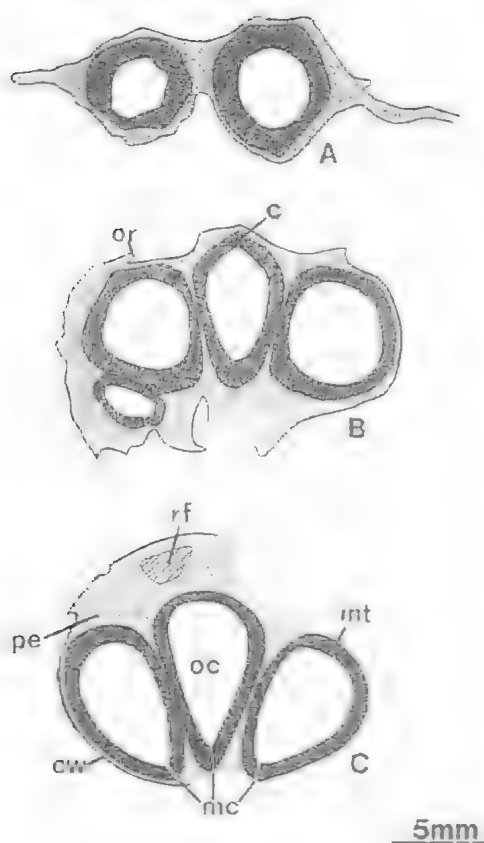


FIG. 11. *Dawesia cupulata* gen. et sp. nov. As for Fig. 10. cw, cupule wall; int, integument; mc, micropylar canal; oc, ovule cavity; or, ornamental rib; pe, pedicel.

order to determine the taxonomic affinities of *Dawesia* particular attention must be paid to the structure of its ovules. In particular the vascularisation, presence of sclerenchymatous bands and the occurrence of secretory tissue are important diagnostic features.

Although there is some differentiation of cells within the integument the cells are all parenchymatous and secretory tissue is lacking. It is assumed that the integumentary cells of *Dawesia cupulata* are primarily thin walled and that this condition does not result from the destruction, during fossilisation, of otherwise thick cell walls thereby leaving only their middle lamellae. The destruction of such thick walled cells has been reported by Srivistava (1946) to have occurred in the integuments of some *Carnoconites* (Form Genus for the ovules of *Pentoxylon*) specimens

he investigated. The single integument of *Dawesia* ovules and its lack of differentiation into three layers, an outer and inner composed of parenchyma with a fibrous middle layer, reduces considerably the taxa to which the genus may be related.

Thus the integument being single rather than double disqualifies *Dawesia* from membership of the Cordaitales, Gnetales and Taxales (Coulter & Chamberlain, 1917) as well as the primitive angiosperms (Denffer et al., 1980). Furthermore, lack of differentiation of the integument excludes *Dawesia* from membership of the Pinophyta, Cycadophyta, Ginkgophyta, Bennettitales (Coulter & Chamberlain, 1917), Caytoniales and Pentoxylales (Sporne 1974).

Attention is therefore drawn to the Mesozoic "seed ferns", Peltaspermales, Corystospermales and Petriellales as possible relatives of *Dawesia* for all these Orders have undifferentiated, unitegmic ovules. Furthermore, ovulate fructifications of both Peltaspermales (Holmes, 1982) and Corystospermales (Holmes & Ash, 1979; Holmes 1982 & 1987; Playford et al., 1982; Retallack, 1980; Shirley, 1898) have been reported from Australia. All reports are from Triassic rocks which are much older than the Kumberilla Beds at Chinchilla. Solely on the basis of its ovule structure *Dawesia* has previously been assigned tentatively to the Peltaspermales by Clifford and Carney (1994). However, the cupulate infructescence of *Dawesia* makes it unlikely that the genus is a peltasperm, the ovules of which are borne on the lower surface of umbrella-like discs. The Corystospermales are also unlikely to be relatives of *Dawesia* because although their ovules are borne in cupules these are uniovulate and the apices of the ovules are curved and bifid.

The cupules of *Petriella* like those of *Dawesia* are embedded in permineralised peat but are much better preserved notwithstanding their Triassic age. Although *Petriella* has multiovulate cupules these differ markedly from those of *Dawesia* in being much smaller, and the ovules are triangular instead of circular in transverse section with the integument forming a distinct tube about the micropyle (Taylor et al., 1994). Accordingly, the two genera cannot be regarded as closely related on the basis of their cupule and ovule morphologies.

Therefore, until further evidence is available, it is appropriate that *Dawesia* be placed in a unique Order of uncertain affinity.

ACKNOWLEDGEMENTS

I thank Department of Earth Sciences, The University of Queensland for preparing sections; the Australian Museum for hospitality; Dora Aitken for the scanning electron micrographs; Mary Dettmann for the photographs presented in Fig. 4; Mary Wade for several kindnesses during the preparation of the paper and Natalie Camilleri for unstinting assistance in preparing the diagrams; Graham Davies and Grace Lithgow provided specimens and guidance in the field; Mike Pole read and offered useful comments upon the manuscript.

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MICROCHIROPTERAN BAT MORTALITY IN A HARP TRAP DUE TO GREEN TREE ANT *OECOPHYLLA SMARAGDINA* ATTACK. *Memoirs of the Queensland Museum*, 38(2): 428. 1995. - Microchiropteran bat mortality in harp traps has been previously reported in Victoria (Schulz & Meggs, 1986; Lumsden, 1989; Wallis & Lumsden, 1993) and the Northern Territory (Underwood, 1994). In Victorian examples, bats were attacked and partially eaten by Bush Rats *Rattus fuscipes*, while in the case from the Northern Territory, mortality was due to Green Tree Ant *Oecophylla smaragdina* attack. This note reports another case of *O. smaragdina* attack on a harp trap which resulted in the mortality of 23 Little Bent-wing Bats, *Miniopterus australis*.

During a fauna survey of coastal wetlands in Trinity Inlet, Cairns, a harp trap was set on a walking track situated on the boundary of a dune ridge community (*Melaleuca leucadendra* overstorey to 10m, with mixed *Acacia craspedocarpa*, *Alysicarpus*, *Excoecarpus latifolius*, *Terminalia muelleri*, *Cupaniopsis anacardioides*, *Pandanus* sp mid storey) and a *Ceriops tagal* dominated mangrove community. The trap was placed between two large *M. leucadendra* and, as the author was aware of the previous case of Green Tree ant attack, care was taken not to rest the trap against, or tie the side anchor-rope onto the surrounding vegetation. The trap was set at dusk, and after a period of spotlighting and ultrasonic bat detection, the trap was checked for the first time at 2230 hours. No bats were present in the trap at the time of the last check, despite a large number of individuals being observed flying overhead and along the track. In addition, no Green Tree Ants were observed on the trap.

The trap was checked at approximately 0600 hours the next morning and 23 trapped *M. australis* were discovered dead in the trap. An extremely large number of *O. smaragdina* (approximate estimate 1000-2000 individuals) were present on the trap, particularly within the folds and spaces of the canvas capture bag and plastic dividing flaps. All bats were covered with large numbers of ants, many of which were also dead. In removing the canvas holding bag and then the bats, the author was attacked and bitten, and fumes excreted by the ants caused gagging and retching. Access to the trap by the Green Tree Ants was from the ground. The trap had been set in similar and slightly more dense vegetation on two previous occasions without attack.

The Green Tree Ant *Oecophylla smaragdina* (Formicidae) is a member of a group known as weaver ants due to their ability to construct arboreal community nests of woven leaves. This odd world genus is widespread throughout tropical Asia, Africa and Australia, and forms large decentralised colonies of up to 500,000 individuals (workers, larvae workers, queens and queen larvae) representing many hundreds of nests in trees covering areas over 1000m² (Hölldobler & Wilson, 1990). Green Tree Ants are renowned for their highly evolved communication and co-operative social systems which include alarm responses, defence and food collection systems and recruitment and exploration strategies, all developed to control and maintain their large home range (Hölldobler, 1983). Short and long-distance recruitment is achieved by a combination of rectal gland odour trails, regurgitation of liquid crop contents, sternal gland secretions, mandibular alarm pheromones, body jerking displays and tactile stimulation. The composition and identity of these chemical signals are colony-specific (Hölldobler & Wilson, 1990).

From the knowledge of Green Tree Ant biology and microchiropteran bat feeding patterns, a scenario for the cause of the attack and subsequent death of the bats in the harp trap can be hypothesised. Recruitment strategies allow Green Tree Ant nestmates to explore and occupy a new space in a very short space of time. Worker ants exploring this territory periodically touch their abdomen tips to the new substrate

leaving drops of brown fluid that act as colony-specific trail markers. Previous studies involving the placement of pot-plants into territorial areas indicated that workers actively enter and search newly opened terrain (Hölldobler & Wilson, 1990). It is suggested that the placement of the harp trap onto the track represented new territory that was rapidly explored and occupied during the course of the evening, before any bats were trapped.

Microchiropteran bats generally demonstrate bimodal feeding activity patterns, with post-dusk and pre-dawn activity peaks (Taylor et al., 1987). In the above case, the harp trap failed to capture any bats during the first period of feeding, despite a high level of observed activity. Therefore the bats subsequently trapped were possibly captured during the pre-dawn feeding period. Between the final trap checking and dawn, large numbers Green Tree Ants explored and occupied the harp trap, utilising the trap-legs as an access point. It is hypothesised that when the bats started sinking and falling into the harp-trap holding bag, this disturbance caused rapid and aggressive defence responses in the ants. Green Tree Ants are highly responsive to substrate vibrations (C. Hill, pers. comm.). The bats were probably killed by a combination of ant-bites and secretions from the Green Tree Ants. Underwood (1994) incorrectly reported that the bats had been 'apparently killed by the repeated stings inflicted by the ants'. Green Tree Ants do not possess abdominal 'stings' but rather use their mandibles to bite and sprays of formic acid from their glands in defensive or attacking responses.

When harp trapping in tropical environments where Green Tree Ants are present, it is suggested that a number of precautions are taken to overcome the possibility of ants accessing and occupying the trap, including: minimising the contact of the trap on surrounding vegetation, not tying the stabilising guy ropes to surrounding vegetation, using surface insect repellent on the trap legs or portions of the trap that are potential access points for the ants and placing the trap legs in small containers of water.

Acknowledgements

Thanks to Dr Chris Hill (Zoology Department, James Cook University). Trapping was conducted under the terms and conditions of Queensland Department of Environment and Heritage permit number T-01182.

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GASTROPODS FROM THE UKALUNDA BEDS AND DOUGLAS CREEK, EARLY DEVONIAN, NORTH QUEENSLAND

ALEX G. COOK

Cook, A. G. 1995 12 01: Gastropods from the Ukalunda Beds and Douglas Creek, Early Devonian, north Queensland. *Memoirs of the Queensland Museum*, 38(2): 429-435, Brisbane, ISSN 0079-8835.

Four gastropods are recognised from the Ukalunda Beds and related sediments from Douglas Creek, Early Devonian north Queensland. This endemic fauna comprises *Tropidodiscus foliatus* sp. nov., *Trochonema* (*Eunema*) sp., *Kitikamispira ukalundensis* sp. nov., and *Hornzyga camilleriae* gen. et sp. nov. *Hornzyga* gen. nov. is erected for palaeozygopleurids with coarse ribbing and a characteristic vertical subsutural surface on the upper whorl face. □ *Gastropods, Devonian, Emsian, Ukalunda Beds, Queensland.*

Alex G. Cook, Queensland Museum, PO Box 3300, South Brisbane, Queensland 4101, Australia; 1 August 1995.

Gastropods are subordinate components of many Devonian fossil assemblages in north Queensland. Diverse, and highly endemic gastropod faunas are known from the Middle Devonian of the Broken River and Burdekin Provinces (Heidecker, 1959; Cook, 1993b). This paper documents the gastropod fauna collected from the Ukalunda Beds and the siliciclastic sediments associated with the Douglas Creek Limestone. Brachiopod, coral, and conodont faunas have been documented from the Ukalunda Beds (Hill et al., 1967; Jell & Hill, 1969; Brock & Talent, 1993). Parfrey (1989) recorded a number of brachiopods, a single taxon of bivalve and an unidentified gastropod from outcrops of the Ukalunda Beds near Mount Coolon. Studies of the faunas of the Douglas Creek Limestone and related siliciclastic units to the immediate south have concentrated on the coralline, brachiopod and conodont faunas (Hill, 1939; Jones, 1941; Phillip & Pedder, 1967; Jell & Hill, 1970; Brock & Talent, 1993). A detailed record of the previous palaeontological work was provided by Brock & Talent (1993), who also discussed evidence for an Emsian age for both the Ukalunda beds and the Douglas Creek Limestone and related siltstones.

Recent stratigraphic mapping by Bennedick (1993) in the Pyramid area informally documented some of the molluscan taxa, namely *Nuculana* sp., *Parallellodon* sp., *Paracyclas* sp., *Leptodesma* sp., and gastropod indet. Study of Bennedick's material forms part of this work.

The four taxa described below are endemic to north Queensland, but there are generic-level links to faunas from New South Wales, northeast Japan and other old world realm faunules.

LOCALITIES AND MATERIALS

Material was collected by the Bureau of Mineral Resources (now AGSO), Macquarie University, Jarrod Bennedick of James Cook University, Townsville, and staff of the Queensland Museum. Details of BMR localities have been recorded by Brock and Talent (1989). James Cook University localities are prefixed JCUL and are detailed in the Appendix along with Queensland Museum localities (QML). Material described herein is registered with the Commonwealth Palaeontological Collections (CPC), Queensland Museum (QMF) and James Cook University (JCUF).

SYSTEMATIC PALAEOONTOLOGY

Phylum MOLLUSCA

Class GASTROPODA

Family BELLEROPHONTIDAE McCoy, 1851

Subfamily TROPIDODISCINAE Knight, 1956

Tropidodiscus Meek & Worthen, 1866

TYPE SPECIES

Tropidodiscus curvilineatus (Conrad) from the Lower Devonian of New York, by original designation.

Tropidodiscus foliatus sp. nov

Fig. 1C-H

MATERIAL EXAMINED

HOLOTYPE: QMF32176 from QML1008.

PARATYPES: QMF32362-4 from QML1005. All material from the Ukalunda Beds, Pyramid Station and Mary Creek, Old Hidden Valley Station.

DIAGNOSIS

Carina well developed; growth lines coarse, well-spaced, foliaceous.

DESCRIPTION

Medium sized, isostrophic, doubly phaneromphalous, up to 12mm wide and 16mm in diameter, bearing a prominent dorsal carina which bears a deep v-shaped sinus. Whorl profile rounded from base of dorsal crest to a weak shoulder, then more strongly rounded into the umbilicus. Ornament consists of prominent, widely spaced foliaceous coarse growth lines, which are gently curved across the whorl profile and strongly inflected adapically at the dorsal crest, but this latter feature varies from early to later parts of the final whorl. Umbilicus deep; aperture expanded. The holotype is 5mm wide and 11mm in diameter.

REMARKS

Prominent dorsal angulation, and foliaceous growth ornament suggest affinity to *Temnodiscus*, but that genus is disjunctly-coiled. *Tropidodiscus cultricarinatus* Linsley, 1968 and *T. vesiculilineatus* Linsley, 1968 from the Middle Devonian Anderdon Limestone, north America, both have the dorsal angulation, but lack the foliaceous growth ornament. The type species *T. curvilineatus* (Conrad), (see Knight, 1941) from the Lower Devonian of New York lacks the angulation and the foliaceous growth lines. *Tropidodiscus centrifugalis* (Chapman) of Tassell (1977) from the lower Devonian of Victoria, does not bear growth ornament as coarse as in the Ukalunda species. *Tropidodiscus* (*T.*) *nakazatensis* Kase & Nishida, 1986, from the Middle Devonian of northeast Japan is close in size and prominence of the carina, but the ornament is finer and the umbilicus narrower in the Japanese material.

ETYMOLOGY

Latin *foliatus*, leaved.

Family TROCHONEMATIDAE Zittel, 1895

Trochonema Salter, 1859

Trochonema (*Eunema*) Salter, 1859

TYPE SPECIES

Eunema strigillatum Salter from the Middle Ordovician Black River Group, Quebec, Canada.

Trochonema (*Eunema*) sp.

Fig. 1A,B

MATERIAL EXAMINED

QMF33369-61 from QML1005, Mary Creek, Old Hidden Valley.

DESCRIPTION

Many-whorled, high-spired, gradate gastropod, greater than 35mm high and 22mm wide with an apical angle of approximately 35°. Suture canaliculate in two of the specimens, particularly in later whorls, with an angulation at its abaxial margin. Whorl profile dominated by a pair of widely spaced midwhorl carinae. A fourth carina is present on the lower whorl profile, but it is only known from the final whorl. Growth lines are fine, numerous, opisthocline on the upper whorl surface, a broad, weak sinus is present between the two midwhorl carina. Base and aperture unknown.

REMARKS

The canaliculate suture, the high-spired form and the broad weak sinus ally the material to the subgenus *T. (E.) strigillatum* (Salter), from the Ordovician Black River Group, as figured by Knight (1941), has stronger growth lines, and is disjunct in the final whorl. Widening of the canal in the final whorl of this material may be precursory to a disjunct whorl. The absence of material defining the apertural and basal features preclude a specific assignment for this material.

Family PALAEOTROCHIDAE Knight, 1956

Kitikamispira Kase & Nishida, 1988

TYPE SPECIES

Kitikamispira kaneoki, from the Middle Devonian (Eifelian) Nakazato Formation, Kitikami Mountains, northeast Japan, by original designation.

DIAGNOSIS

See Kase & Nishida (1988).

REMARKS

Kase & Nishida (1988) remarked on the similarities between *Burdikinia* Knight, 1937 and *Kitikamispira*. *Burdikinia burdekinensis* (Etheridge) is a substantially different form, having only the surface spines and large size as similarities. Kase & Nishida (1988) state that the type species, *K. kaneoki*, possesses only one row of spines on the upper whorl surface and four on

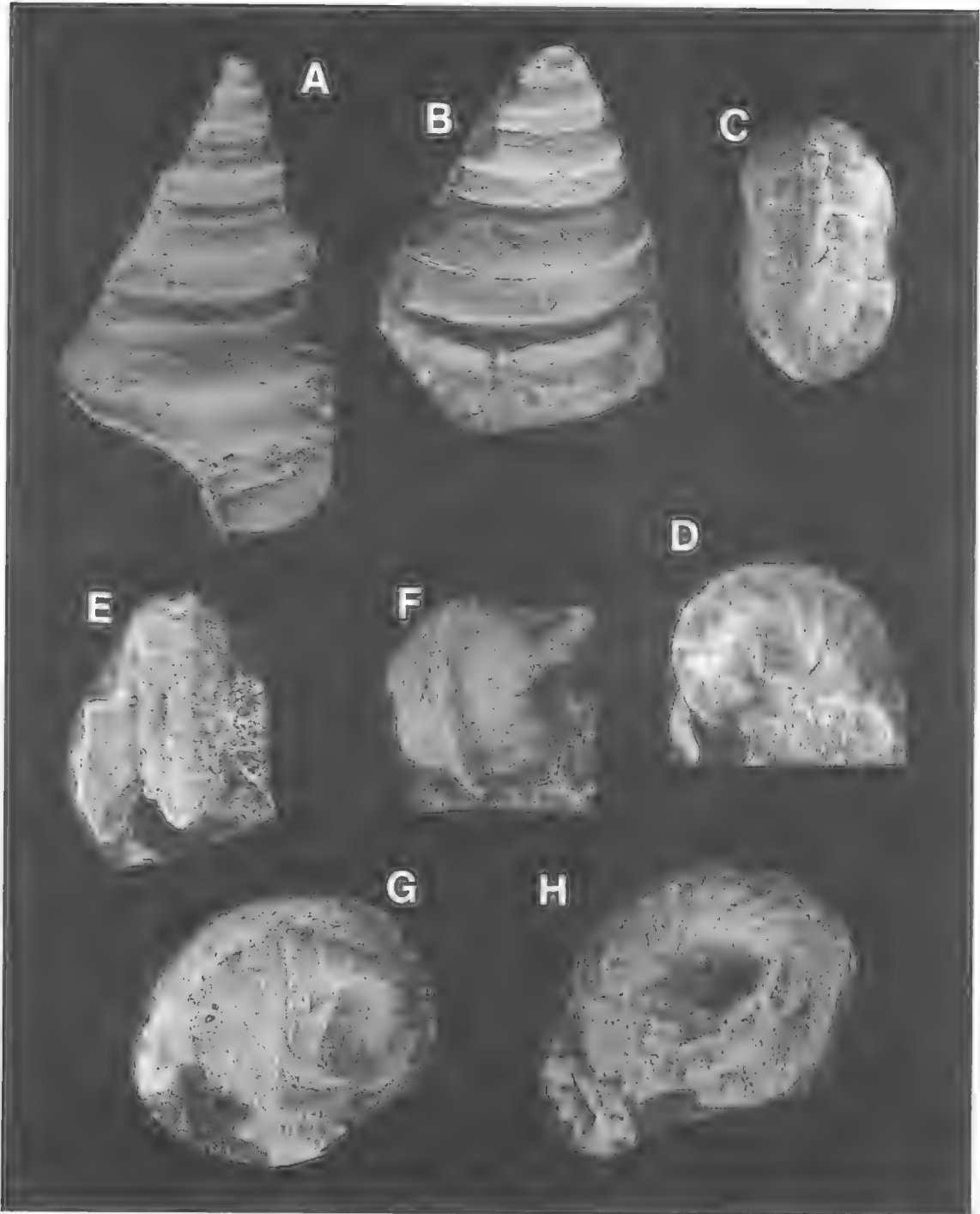


FIG. 1. A-B, *Trochonema* (*Eunema*) sp. A, latex mold of QMF33359 x 1.8. B, latex mold of QMF33360 x 1.8. Note the widening of canal in last preserved whorl. C-H, *Tropidodiscus foliatus* sp. nov. C, holotype QMF32176 apertural view, x 3. D, holotype QMF32176 side view x 2.8. E, latex mold of paratype QMF33364, apertural view x 2.5. F, latex mold of paratype QMF33367, oblique view x 2. G, latex mold of Paratype QMF33364, side view x 3. H, latex mold of paratype QMF33362, side view x 2.6.

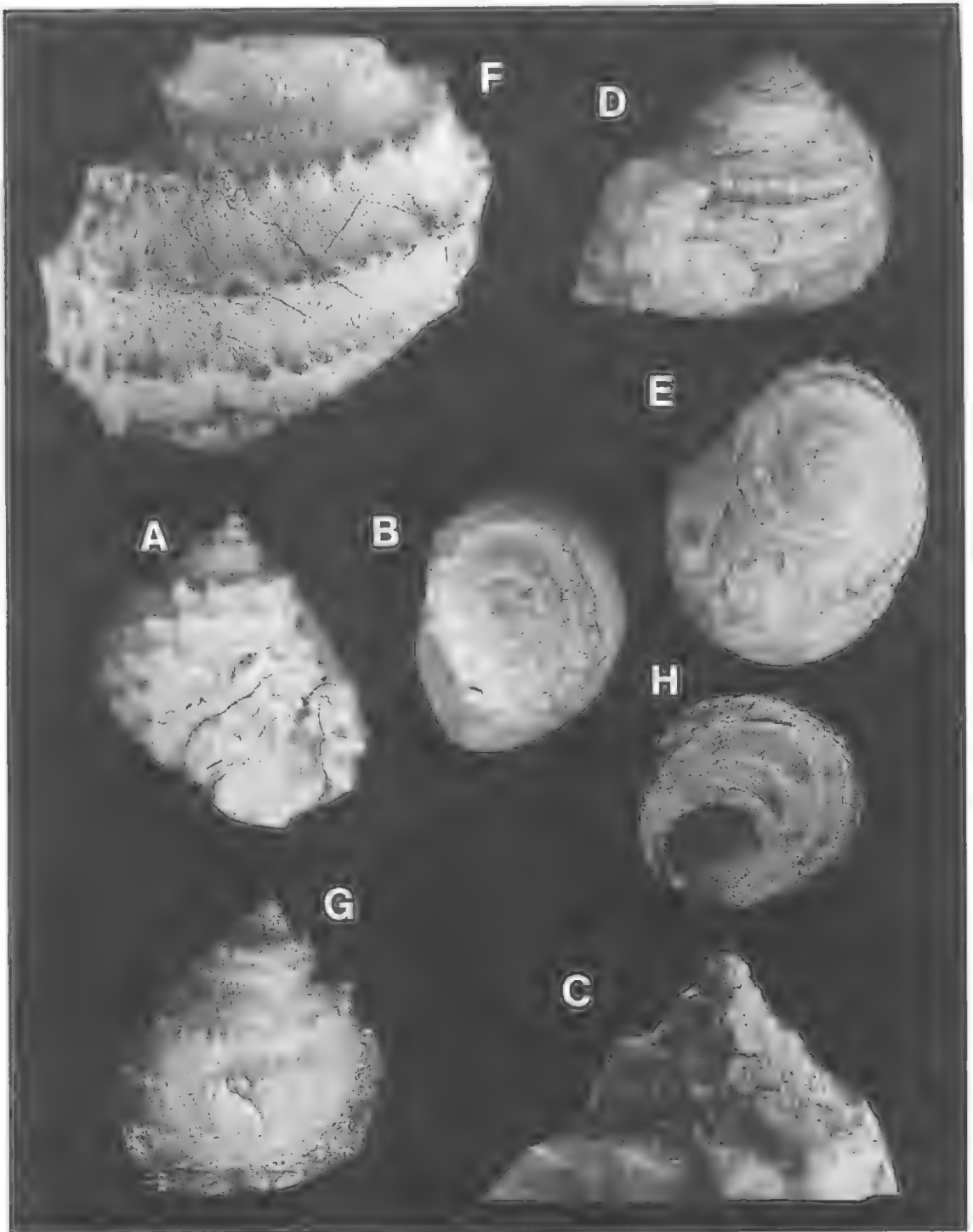


FIG. 2. A-H, *Kitikamispira ukalundensis* sp. nov. A-C, holotype QMF33358. A, apertural view x 2.7. B, apical view x 2.7. C, side view showing protoconch x 5. D, E, paratype QMF32179, side and apical views, x 2.8. F, latex mold of QMF33371 side view x 6.5. G, latex mold of paratype QMF 33354, side view x 2.8. H, latex mold of paratype QMF33372, basal view x 2.8.

the base, but their illustrations show one on the uppermost whorl surface, two on the midwhorl, and up to three on the lower whorl surface. *Orisotoma* Munier-Chalmas, 1876 is phanacromphalus, but has a similar, if finer and more complex arrangement of spinose spiral cords. Kase & Nishida (1988) placed the genus within the Palaeotrochidae, apparently on the basis of the thickened shell and the thickened parietal region.

***Kitikamispira ukalundensis* sp. nov.**

Fig. 2

1989 Gastropod indet. Parfrey: 20.

MATERIAL EXAMINED

HOLOTYPE: QMF33358, from "loc. 76", Mary Creek Old Hidden Valley, collected J. A. Talent.

PARATYPES: QMF32179, 32180 from QML1008, QMF33353-33357, QMF33371, 33372 from QML1005. OTHER MATERIAL: GSQF13456, from GSQL2765, JCUF12779 from JCUL810, CPC33678, from CL172, tentatively assigned to this species.

DIAGNOSIS

Small, *Kitikamispira* with flattened whorl profile between suture and first spiral row of spines.

DESCRIPTION

Small to medium, medium spired, turbiniform, gastropod up to 19mm high and 19mm wide, with an apical angle of c.50°. Whorl profile generally rounded, but flattened in the uppermost whorl surface. Whorl surface bears 5 rows of spirally arranged spines, in some specimens upon a weak thread. There is one row of spines at the edge of the subsutural shelf, two rows at the midwhorl periphery, and two on the lower whorl face. Spines are slightly elongate along the spiral cords, numerous, with approximately 14 per row per whorl; some are directed slightly abapically. Sutures slightly impressed, situated just below the midwhorl and the third row of spines, so that the spines are exposed on the flattened subsutural shoulder. The protoconch is preserved on the holotype, it consists of two unornamented volutions, the first vertically coiled and the second dextral and horizontally coiled; or "deviated paucispiral" of Knight et al. (1960). Aperture is rounded; the shell is moderately thick for its size, and appears thickened in the parietal region but the apertural region is broken in this material. Growth lines fine, strongly prosocline upon the upper whorl surface, nearly orthocline on the

midwhorl, and where preserved appear to be prosocline on the lower whorl surface.

REMARKS

This species is smaller than the type, and has a higher spire. It retains a similar arrangement of the spiral nodes, but the position of the uppermost row of spines is more adapertural and the whorl profile from the suture to the uppermost row of spines is more flattened. The parietal callus, present in the type, is missing in this material. The external mould from Douglas Creek is a very poorly preserved specimen, probably conspecific with the Ukalunda material. I have examined material mentioned by Parfrey (1989) and Benedetto (1993) which is certainly conspecific.

ETYMOLOGY

For the Ukalunda region.

Family PALAEOZYGOPLEURIDAE

Horný, 1955

***Hornzyga* gen. nov.**

TYPE SPECIES

Hornzyga cumilleriae sp. nov.

DIAGNOSIS

Vertical unornamented surface below the suture, generally rounded midwhorl profile bearing coarse collabral ribs.

ETYMOLOGY

For Radvan Horný.

REMARKS

Palaeozygopleura Horný seems to encompass forms with finer collabral ribs, and no shoulder, such as *Loxonema roemeri* of Whidborne (1892), and *Palaeozygopleura muoni* Tassell 1982. Linsley (1968) seems to adopt a wider view of the genus by the inclusion of the slightly coarser ribbed *Palaeozygopleura sibleyense* Linsley from the Middle Devonian Anderdon Limestone. Further latitude given to the importance of size and rib coarseness within *Palaeozygopleura* may accommodate *Loxonema scalariaeforme* Holzappel of Whidborne, 1892 and *Loxonema altacostatum* Tassell, 1982 which is anomalous within *Loxonema*. *Devonozyga* Horný, 1955 possesses a distinct shoulder and thicker ribs. *Hornzyga* is separated from both *Palaeozygopleura* and *Devonozyga* by the vertical surface below the suture, and restriction of the ornament to the wide midwhorl.

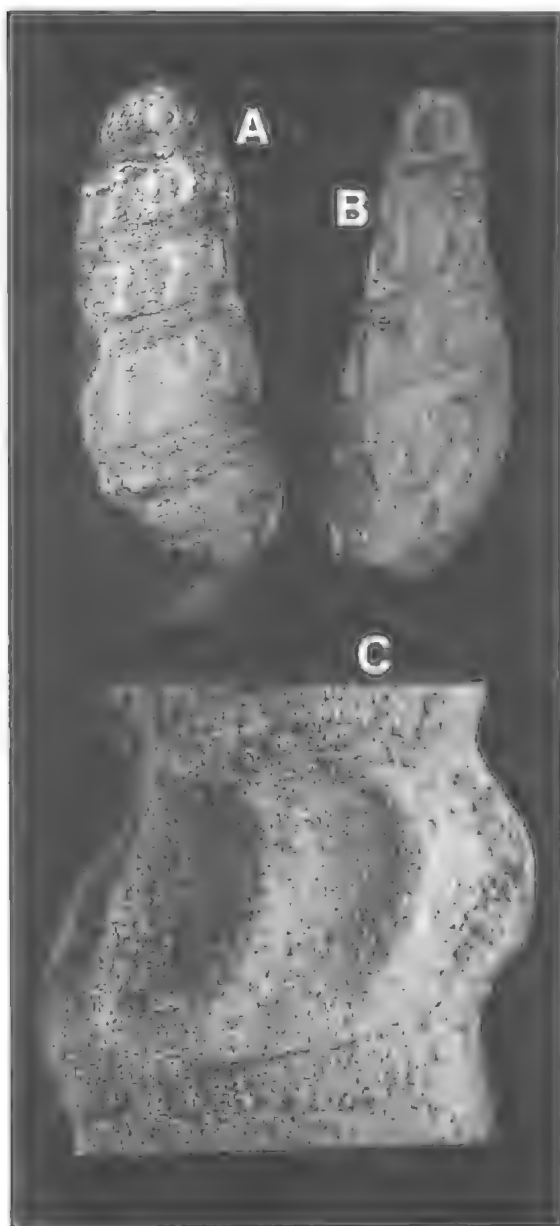


Fig. 3 A-C. *Hornyzyga camilleriae* gen. et sp. nov. A, Latex mold of holotype QMF33385, apertural view x 2.2. B, Latex mold of Paratype QMF33369, side view x2. C, Latex mold of holotype QMF33385, x 6. Note the flattened subsutural areas.

Familial placement may be considered problematic without protoconch material, following Horny (1955) and Knight et al. (1960), but seems reasonable given the gross morphological similarities.

Hornyzyga camilleriae sp. nov.
Fig. 3 A-C

DIAGNOSIS

As for genus.

MATERIAL EXAMINED

HOLOTYPE: QMF33385 from QML1005.

PARATYPES: QMF33369-70 from L1006, QMF33386 from QML1005

DESCRIPTION

Medium sized, high-spired, many-whorled, up to 30mm high and 11mm wide, with an apical angle of c.15°. Sutures adpressed, sutural slope shallow. Midwhorl surface is dominated by thick collabral ribs, approximately 12 per whorl, which are variably opisthocline. Below the suture is a vertical and unornamented surface, but the whorl profile is convex where it bears the thick ribs. There is a vertical unornamented area below these riblets upon the final whorl, and below this the lower whorl profile is smooth and rounded. The suture is situated just below the midwhorl ribs. Aperture is apparently rounded. Growth lines unknown. Protoconch unknown. The holotype is 30mm high and 10mm wide, but lacks a protoconch. Paratype QMF33369 is crushed, and QMF33370 is represented by two late whorls.

REMARKS

Loxonema altacostatum Tassell, 1982 from the Early Devonian of Taemas, New South Wales, lacks the subsutural surface of this taxon, giving the Taemas species a more rounded and even whorl profile. Tassell's species is better placed within *Palaeozygopleura*. Other ribbed *Loxonema* include *L. roemeri* Kayser of Whidborne (1892) from the Devonian of Devon, which also lacks the subsutural surface, and tends to have a more orthocline to prosocline arrangement of closely spaced riblets. *L. scalariaeformis* Holzapfel of Whidborne (1892) has more impressed sutures and also lacks the subsutural surface.

ETYMOLOGY

For Natalie Camilleri.

ACKNOWLEDGEMENTS

I thank Peter Jell & Chris Tassell for comments on the manuscript, Bob Henderson, Des Strusz and Susan Parfrey for loan of materials, and Natalie Camilleri for field assistance.

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APPENDIX

- QML1005 Un-named tributary of Mary Creek, 80m from creek in prominent eroded gullies, 20° 47.7' S, 147° 20.2' E, Old Hidden Valley Station. Ukalunda Beds. Collected A. Cook & N. Camilleri, 1994.
- QML1006 Un-named tributary of Mary Creek, 200m NE of L1005, section centred on 20° 47.7' S, 147° 20.3' E, Old Hidden Valley Station. Ukalunda Beds. Collected A. Cook & N. Camilleri, 1994.
- QML1008 Small un-named creek 1.5km S of 'Sugarloaf Dam', at 20° 55.4', 147° 3.8', Pyramid Station, Ukalunda Beds. Collected A. Cook & N. Camilleri, 1994.
- GSQ12765 Northern tributary of Boundary Creek, at metric grid GR 009 539, Mt Coolon 1:100 000 sheet (8355) Ukalunda Beds. Collected C. Wilkinson, 1988.
- JCUL810. Un-named creek, 1.5km west of 'The Sugarloaf' at metric grid GR C68 868, Glendon 1:100 000 sheet, Pyramid Station. Collected J. Bennedick, 1993.

TWO SIGNIFICANT VERTEBRATE FAUNA RECORDS FROM MID-ALTITUDE WET TROPICAL RAINFOREST, LAMB RANGE STATE FOREST. *Memoirs of the Queensland Museum* 38(2): 436, 1995:- A fauna survey of low to mid altitude wet tropical rainforest on the eastern escarpment of the Lamb Range State Forest (17°00'S, 145°40'E) was conducted as part of the Queensland Electricity Commission's Chalumbin-Woree 275 kV transmission line environmental impact statement. Much of the study area is dominated by vegetation type 2a mesophyll vine forest, with small areas of types 8, 13c, 13f, 14 and 16a (Tracey, 1982; Kutt et al., 1995). The survey examined 25 potential ridge-top lower sites ranging in altitude from 300-700m including the linear habitat corridor between them. A total of 173 vertebrate fauna species were recorded (Kutt et al., 1995) including twelve of conservation significance. Two of these are considered to be noteworthy and are reported below.

Northern Bettong *Bettongia tropica*

Locality: 17°01'20"S, 145°40'20"E, *Altitude:* 620m, *Date:* 10 November 1994, *Habitat:* ridge top (spur), leading to higher altitude forest, *Vegetation:* Type 13c vine forest with emergent *Eucalyptus grandis* and midstorey *Acacia melanoxylon*, *A. ulacocarpa* (Tracey, 1982), *Record type:* hair sample in canine faecal pellet, *Number of individuals recorded:* unknown, likely to be single, *Conservation status:* Endangered (Schedule 1, Commonwealth Endangered Species Protection Act 1992).

The Northern Bettong is thought to be restricted to a narrow band of tall open forest (typically *Casuarina torulosa* forest and medium *Eucalyptus acmenoides*, *E. phaeotricha*, *E. intermedia* woodland/open forest) on the western edge of the Wet Tropics World Heritage Area, running from Mt Windsor to Ravenshoe (Winter et al., 1991). The site where the Northern Bettong hair sample was collected represents atypical habitat for this species, though it has been historically recorded from closed forest communities (K. Vernes, pers. comm.). It is likely that the hair sample originated *ex-situ*, as canine predators utilise large home ranges (e.g. av. 21 km² for Dingos in south-east Australian forests, av. 39 km² in Kakadu (Corbett, 1995)), with vagrant individuals foraging over even larger distances. Numerous old forestry tracks also traverse the region, which would facilitate rapid movement of large mobile predators. The closest known populations occur 10 km west (straight-line distance), adjacent to Davies Creek National Park. However, given past records of *B. tropica* using rainforest habitat and the occurrence of potentially suitable open forest and rainforest communities in the region between where the hair sample was recovered and Davies Creek, there is a possibility that individuals or populations may exist in other areas in the Lamb Range State Forest.

Flute-nosed Bat *Murina florium*

Locality: 16°59'20"S, 145° 37'00"E, *Altitude:* 640m, *Date:* 21 October 1994, *Habitat:* ridge-top, along access track to transmission line clearing, *Vegetation:* Mesophyll vine forest type 2a, with fringing 13c vine forest (with emergent *Eucalyptus grandis*, midstorey *Acacia melanoxylon*, *A. au-*

lacocarpa) on surrounding ridge lines (Tracey, 1982). *Record type:* harp-trap, *Number of individuals recorded:* single male, forearm 35.5mm, *Conservation status:* Vulnerable (Queensland Nature Conservation [Wildlife] Regulation, 1994), *Sympatric species trapped:* Eastern Horseshoe Bat *Rhinolophus megaphyllus*.

The Flute-nosed Bat was once considered Australia's 'rarest' mammal by virtue of a single record from clouded upland (1120 m) rainforest (Richards et al. 1983). More recent records include specimens from upland rainforest (>1000m asl) near Ravenshoe, lowland rainforest (<250m) at Rowville and Gap Creek, Cedar Bay, NEQ (H. Spencer, pers. comm.) and from specimens of uncertain taxonomic status from Iron Range (Van Dyck, 1991).

Published knowledge of the bats biology and habitat is limited (Richards et al., 1983; museum records). The capture reported here represents the first mid-altitude record for the species and the first from the Lamb Range State Forest and surrounding region.

Acknowledgements

I thank Marc Hero, Hugh Spencer, Karl Vernes, (James Cook University, Townsville) and Trevor Hunt (Queensland Electricity Commission). Barbara Triggs (c/- Dead Finish, Geelong, Vic, 3891) identified the Northern Bettong hair sample. Trapping was conducted under QDEH permit to take no. T-01181 and the QDPI forestry permit to collect no. 751/2.

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- A.S. Kutt, Australian Centre for Tropical Freshwater Research & S.E. Burnett, Zoology Department, James Cook University, Townsville, Queensland 4811, Australia; 10 June 1995.

THE MAYTOWN OCHRE SOURCE

BRUNO DAVID, ALAN WATCHMAN, ROSEMARY GOODALL & ERIC CLAYTON

David, B., Watchman, A., Goodall, R. & Clayton, E. 1995 12 01: The Maytown ochre source. *Memoirs of the Queensland Museum* 38(2): 441-445. Brisbane, ISSN 0079-8835.

The mineralogy and elemental fingerprint of a well-defined ochre source near Maytown, north Queensland are described. Characteristics of the ochre were investigated via petrographic, XRD, SEM/EDXA, FTIR and PIXE/PIGME analyses. Potential archaeological implications of this source are briefly explored. □ *Ochre, sourcing, rock art, north Queensland, Australian prehistory.*

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Earth pigments (ochres) were, and in many places continue to be, commonly used by Aboriginal people to paint, draw, stencil or print on a variety of surfaces (e.g., wooden objects, cave walls, bodies). Ochres were sometimes obtained from distant places, at times measuring in the thousands of kilometres. This was especially the case with ochres of high repute, be it for their particularly high physical qualities or for their special Dreaming significance (e.g., Peterson & Lampert, 1985; Sagona, 1994). In this paper, we differentiate between a *source*, being a location of readily available raw material (not necessarily exploited), and a *quarry*, being a demonstrably exploited source.

Once characterised, well-defined ochre sources offer archaeologists the potential of provenancing ochre excavated from archaeological deposits. Once archaeological specimens are provenanced, prehistoric trade or exchange networks and systems of inter-regional interaction can be reconstructed. For such a program to succeed, however, elemental and/or mineralogical 'fingerprints' of specific sources need to be first established. To date, the characteristics of potential sources of ochre have been almost totally ignored (but see David et al., 1993; Sagona, 1994). This has resulted in a dearth of information fundamental to the sourcing of archaeological specimens. This paper thus aims to initiate a program of 'fingerprinting' ochre sources in northern Australia. So far, our efforts have concentrated on ochrous pebbles from creek and river beds. The boundaries of such sources tend to be ill-defined, although in north Queensland well-defined ochre sources and quarries are extremely rare. In this paper, we report one occur-

rence of a well-defined and highly localised ochre source from north Queensland, here referred to as the Maytown Source.

THE SOURCE

The Maytown source is located in the bed of the Palmer River, immediately west of the now abandoned town of Maytown, north Queensland (Limestone Creek 1:50,000 map sheet, edition 1-AAS, Grid Reference AC892287). The source is entirely submerged under water during the wet season, but totally exposed during the dry. It is an extremely localised and well defined outcrop of weak red to dark reddish gray pigment (dry Munsell 10R 4/2 to 2.5YR 4/2), measuring c.30 x 30 x 1.5m (Fig. 1). The source does not show any evidence of previous extraction, although prehistoric quarrying activity would be extremely difficult to detect given the friable nature of the ochre and the annual flooding of the outcrop in the Palmer River bed. No other ochrous outcrops have yet been noted nearby.

The ochre appears to be homogeneous to the naked eye. A large piece of ochre (c.20 x 10 x 5cm) and a few smaller pieces were detached by us from the block outcrop for mineralogical and elemental analyses. The results are presented below.

X-RAY DIFFRACTION (XRD)

A flake broken from a larger piece of the Maytown ochre source was pulverised and finely ground using an agate pestle and mortar. An XRD pattern (Laval University spectrum #3569) was obtained using a Siemens diffractometer equipped with a Copper anode (1.54184K α X-rays) operated at 40kV and 20mA. Two theta scan

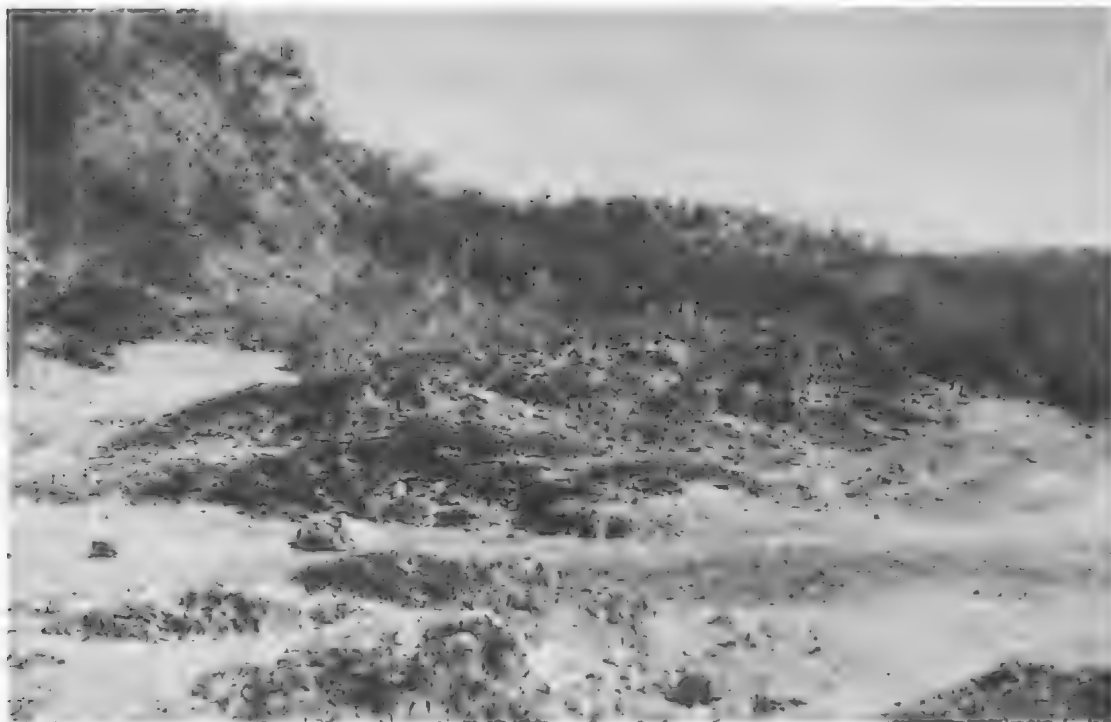


FIG. 1. The Maytown Source.

range was from 5 to 65 degrees at 10 degrees two theta/minute and a time count of 1.2 seconds.

The spectrum of the pigment is predominantly quartz with minor muscovite (Fig. 2).

SCANNING ELECTRON MICROSCOPE ENERGY DISPERSIVE X-RAY ANALYSIS (SEM/EDXA)

SEM observations and analyses were made on two sub-sample flakes, mounted carbon discs and coated with Au-Pd, using a JEOL JSM-840A SEM with a germanium window and equipped with a Tracor Northern energy dispersive X-ray analytical system. Operating conditions were 15kV and 100µA with a working distance of 15mm.

A relatively uniform composition was measured across the broken pigment samples. Qualitative assessment of elements present include Si, O, Al, Fe and K (Fig. 3). There may also be a very slight trace of carbon-bearing mineral, but the very low peak could also reflect a slightly higher background. Secondary electron images of the fractured surfaces (Fig. 4) show a sub-parallel arrangement of platy crystals, typical of a schist. The visual microscopic observations and the elemental compositions, when combined, indicate that the pigment is a ferruginised quartz-mica schist.

FOURIER TRANSFORM INFRARED ANALYSIS (FTIR)

The infrared spectrum was recorded using a Perkin Elmer FTIR 2000 with a MTEC photoacoustic detector on a solid piece of ochre. The spectrum (Fig. 5) indicates a mica species with bands typical of muscovite or sericite. Small bands in the OH stretching region of the spectrum indicate small amounts of a clay mineral. A small

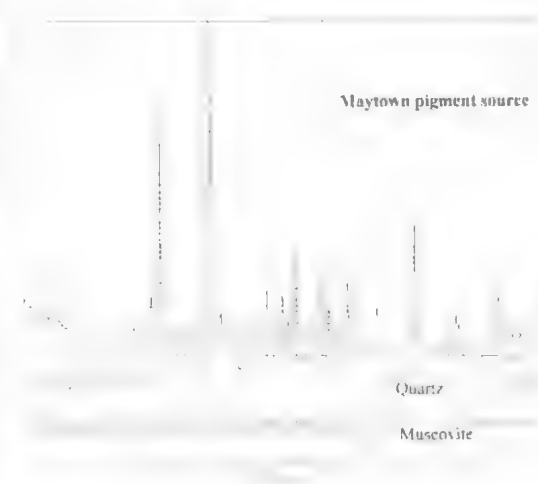


FIG. 2. XRD spectrum.

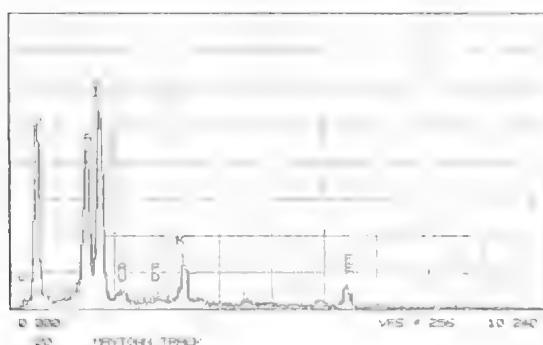


FIG. 3. SEM/EDXA spectrum.

band at 1430cm^{-1} indicates a carbonate in the sample.

PIXE/PIGME

The PIXE/PIGME results were recorded on the 2.5 MeV van der Graff accelerator facility at Lucas Heights. A pinhole filter was used to reduce the effects of high Fe concentrations. Seven samples were analysed in two separate runs (four

samples in 1990 and three in 1994). The 1994 samples (1-3 in Table 1) are those used for infra-red analysis. Raw results were calibrated against geological standards and calculated using the PIXAN package (Clayton, 1986). Quantitative assessment of 28 major and trace elements was made, and the results of 15 elements are given in Table 1. The presence of Ca, Ti and Na in minor amounts (1-4%) appears to be typical of ochres from this region (David et al., 1993). Fe is present in high amounts, as is to be expected for a red coloured material. Si and Al are also major elements, K is present as a major component; this is consistent with a muscovite-mica type mineralogy.

Multivariate (Average Linkage Cluster) analysis undertaken on nearly 100 red ochre samples from northern Australia have linked the seven Maytown source samples presented here into a single cluster, separating out from all the other (non-Maytown source) samples. The implication is that, on elemental characteristics alone, the Maytown source is quite distinctive from the other known ochre sources of northern Australia.

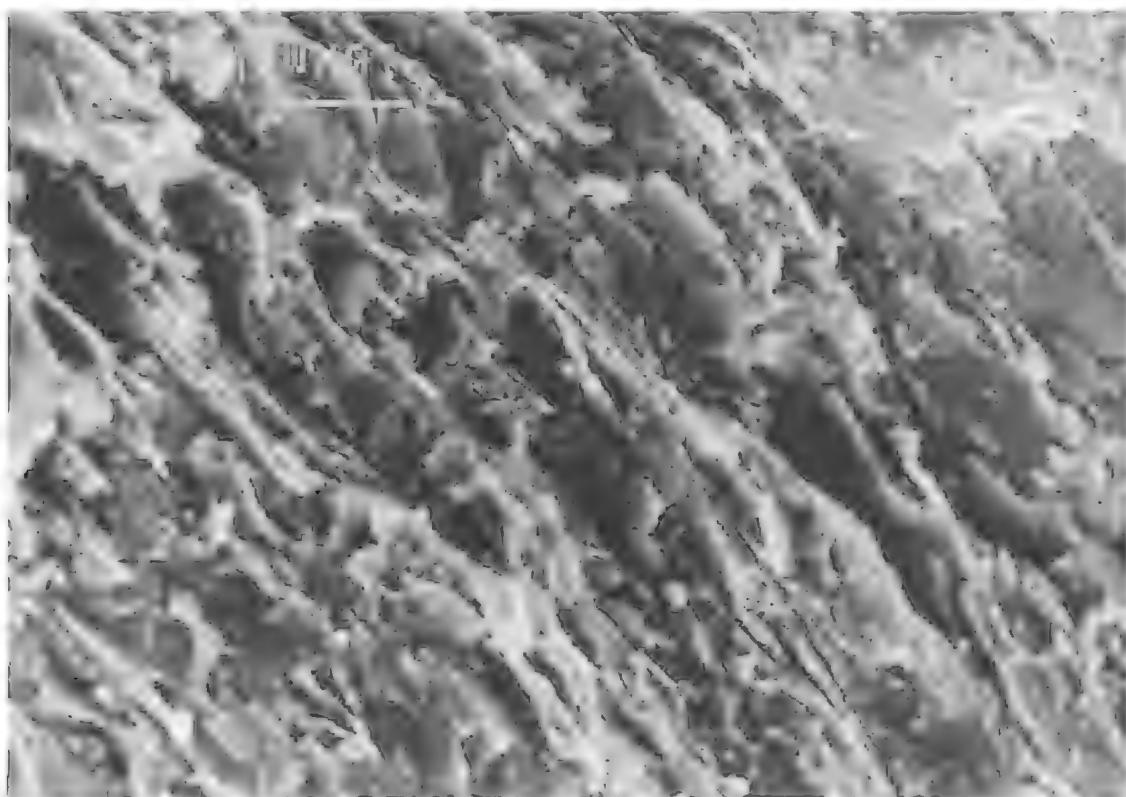


FIG. 4. SEM image. Scale = μm .

TABLE 1. Element concentrations determined by PIXE/PIGME analysis. All concentrations are mg/kg unless noted as weight percent.

No.	1	2	3	4	5	6	7
F	764.0	794.0	913.0	890.9	616.5	666.4	1005.5
Na	4505.0	3258.0	4234.0	4430.8	3680.7	4387.0	4194.4
Al(%)	8.1	8.5	8.9	9.0	7.4	7.0	9.9
Si(%)	32.7	29.0	33.5	41.3	39.5	43.3	37.5
K(%)	3.4	3.5	4.0	4.7	3.3	3.5	5.4
Ca	900	1100	1100	400	400	900	500
Ti(%)	0.5	0.5	0.5	0.5	0.6	0.5	0.6
Mn	993.0	376.0	488.0	72.8	142.9	61.4	712.5
Fe(%)	4.8	5.3	5.0	6.1	3.7	5.8	5.5
Ni	23.0	15.0	15.0	6.6	0.0	13.7	36.5
Cu	6.0	14.0	6.0	29.3	0.0	15.6	10.3
Zn	70.0	81.0	52.0	52.4	40.0	100.4	46.8
Rb	199.0	173.0	227.0	216.3	167.5	206.7	257.5
Sr	71.0	76.0	123.0	63.3	70.2	73.9	65.8
Zr	140.0	138.0	137.0	13.2	0.0	0.0	0.0

The results of these investigations will be presented elsewhere.

The Maytown ochre source, a ferruginised quartz-muscovite schist, is the first to be systematically described from north Queensland. Limited by a lack of comparative material, it is therefore too early to determine with any authority whether or not local cave paintings were made with this material. Nevertheless, preliminary

mineralogical investigations of paintings from the Blue Figures, Cockatoo, Quinkans, Longtom and Mushroom Rock art sites near Laura (to the immediate north of the Maytown Source) have revealed similar, although not identical, mineralogical and SEM/EDXA features to the Maytown pigment source (Watchman et al., 1993). This does not prove that pigment samples from the Maytown Source were used in Laura paintings, but it does suggest that similar geological material in the Lower Proterozoic Hodgkinson Formation (de Keyser & Lucas, 1968) was used as a rock painting pigment. It also highlights the need for a detailed mapping of potential pigment sources across north Queensland. It is only under such a research program that definitive statements on the provenance of archaeological ochres will be warranted.

ACKNOWLEDGEMENTS

We thank Mr. and Mrs. Wilson for allowing us to collect samples of the Maytown ochre; the Department of Anthropology and Sociology, the University of Queensland and the School of Chemistry (especially J. Bartley, G. Kimber & P. Fredricks), Queensland University of Technology for support, and the Australian Institute of Nuclear Science and Engineering (AINSE) for two separate grants (to David and Goodall) to undertake PIXE/PIGME analyses at the ANSTO laboratories at Lucas Heights.

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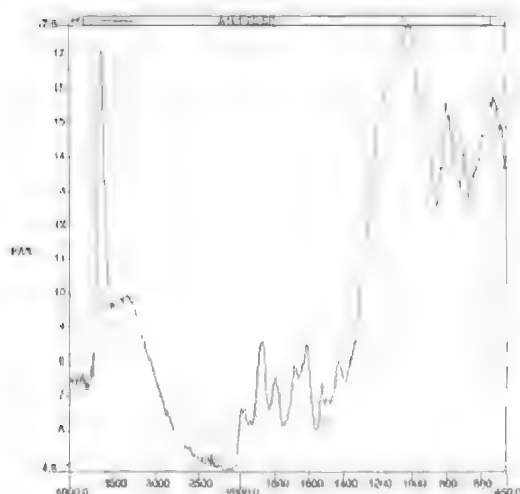


FIG. 5. Fourier Transform Infrared Photoacoustic (FTIR-PAS) Spectrum.

WATCHMAN, A., SIROIS, J. & COLE, N. 1993.
Mineralogical examination of Aboriginal rock-
painting pigments near Laura, north Queensland.
Pp. 141-150. In Fankhauser, B. & Bird, R. (eds.),

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Canberra).

DEGRADED RIPARIAN HABITAT AT CHARTERS TOWERS AND ITS POTENTIAL TO DECREASE LOCAL DIVERSITY AND/OR CAUSE EXTINCTIONS. *Memoirs of the Queensland Museum* 38(2): 446, 1995. The importance of riparian zones as natural wildlife corridors, as refuges during dry seasons and as centres of increased species diversity and abundance has been well documented (Redford & de FONSECA, 1986; Bennett, 1990; Williams, 1994). In northern Australia, riparian zones form narrow corridors of mesic streamside habitat extending into drier inland woodlands (Williams, 1994), and allow species otherwise unable to survive in arid and semi-arid habitat (e.g. aquatic, semi-aquatic, coastal and wetter forest species, migratory species) to expand into these areas (Land Conservation Council, 1987). Features of riparian vegetation that contribute to the observed high diversity and abundance of fauna include its floristic and structural diversity and hence, the higher availability of resources (Bennett, 1990; Williams, 1994). Riparian habitats are therefore important sites for local and regional species conservation. If riparian habitat is degraded or altered, there is a potential for a decrease in species diversity and abundance, and possibly for short and long term species extinctions.

A short terrestrial flora and fauna survey of riparian habitat was conducted in June 1994 on the Burdekin River near the Charters Towers Weir by the Australian Centre for Tropical Freshwater Research, James Cook University of North Queensland. The study area comprised the river impoundment and riparian zone to the high levee bank, to a point 8 km upstream of the current weir. Vertebrate fauna was surveyed using a combination of Elliott and cage trapping, spotlighting, active searching and bird census. Vegetation was surveyed by foot traverse. Secondary sources for flora and fauna records were also examined. A total of 88 bird, 12 mammal (four introduced), seven reptile and one introduced amphibian species were recorded during the present survey. Additional sources (Queensland Museum records; White, unpubl. data) list a further four native mammals, six reptiles and four bird species. A total of 99 vascular plants were recorded, 35% of which were exotic. Three major vegetation communities were identified: *Metaleuca leucadendra*, *M. argentea* and *M. viminalis* river bed and bank community, tall (up to 25 m) closed to open *Eucalyptus tereticornis* woodland on the first levee bank; tall to medium open mixed species woodland (*E. tessellaris*, *E. erythrophloia*, *E. papuana*, *E. dolichocarpa*, *E. drepanophylla*) on the highest levee bank.

Exotic species dominated the understorey in all vegetation types surveyed. Of particular concern is infestation of Rubber Vine *Cryptostegia grandiflora*, which threatens the long-term viability of the two woodland communities. Open canopy observed in the *E. tereticornis* community is an artefact of this exotic species reaching the canopy and killing mature trees. Recruitment of trees in the mid and understorey was evident, but these were also being smothered. Extensive grazing of cattle along the river bank has also degraded the native vegetation in the riparian zone. As a result, ground cover has been substantially reduced (in some cases 15–20%), exotic invasion enhanced, soil erosion increased and recruitment of native species decreased.

Though the bird community was diverse and species rich, 24% of these were waterbirds, present in high numbers due to the impoundment. Excluding waterbirds, 47% of all species recorded were 'uncommon' (<5 observed). A number of typical riparian and woodland species that forage in the shrub and ground layers were observed to be of reduced abundance

or absent (e.g. beanthizids, sylviids, muscicapids, cuculids, malurids). Medium to large macropods (6 spp.) and feral species (4 spp.) were the dominant element of the terrestrial fauna. No small ground-dwelling mammals were recorded either by live trapping or by secondary sources. This is a typical pattern throughout arid and semi-arid Queensland (Van Dyck, 1991), though confirmation of the total absence of small terrestrial fauna in the study area requires further survey. Both observed patterns are a reflection of extremely poor condition and quality of the ground and shrub flora, and overall vegetation community structure. Exotic weed invasions, excessive grazing, unrestricted bank access by cattle and river bank erosion have all combined to create a riparian habitat that is degraded and unlikely to act as a refuge for fauna or as a centre of increased biotic diversity and abundance. Two large vertebrate species recorded have the potential to become extinct in the study area within the near future. A nesting pair of White-bellied Sea-eagles and a Greater Glider *Petaurides volans* were recorded in the Queensland Blue Gum *E. tereticornis* woodland. As outlined above, this community is heavily infested with Rubber Vine, and has already regressed from a closed woodland to an open woodland as a result of the loss of mature trees. Loss of the dominant overstorey would result in the loss of nesting, denning and breeding resources for these two species. Therefore the conservation status of these two species in the local area is considered to be 'endangered'—species at serious risk of disappearing from the wild state within 10–20 years if present land use and other causal factors continue to operate (Ingram & Raven, 1991).

A number of limitations may have influenced many of the patterns observed including a relatively short survey, season and prevailing drought conditions. Riparian areas are important sites for local and regional species diversity and conservation, especially in sub-optimal conditions, and degradation within such zones creates the potential for a reduction in biodiversity and local species extinctions. Degraded riparian habitat and vegetation such as this is prevalent throughout the Burdekin-Haughton catchment and the careful management and rehabilitation of these zones should be a priority for conservation within this region.

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NEW RECORDS OF *CRYPTOPODIA* (CRUSTACEA: DECAPODA: PARTHENOPIDAE) FROM AUSTRALIA

P.J.F. DAVIE & P.A. TURNER

Davie, P.J.F. & Turner, P.A. 1995 12 01: New records of *Cryptopodia* (Crustacea: Decapoda: Parthenopidae) from Australia. *Memoirs of the Queensland Museum* 38(2): 447-462. Brisbane. ISSN 0079-8835.

Six species of *Cryptopodia* are recorded from northern Australian waters and an identification key is provided. Three, *C. angulata* H. Milne Edwards & Lucas, 1841, *C. dorsalis* White & Adams, 1847, and *C. pan* Laurie, 1906, are new to the Australian fauna and represent large range extensions. The known range of *C. queenslandi* Rathbun, 1918, is extended, and allometric growth is noted for this species. Dorsal and ventral photographs, and figures of the male first gonopods, are provided for all six species. □ Crustacea, Brachyura, Parthenopidae, *Cryptopodia*, Indo-West Pacific, Australia.

P.J.F. Davie & P.A. Turner, Crustacea Section, Queensland Museum, P.O. Box 3300, South Brisbane, Queensland, 4101 Australia; 20 September 1995.

Collections on which the current study is based were largely provided by two surveys undertaken by the Commonwealth Scientific and Industrial Research Organisation (CSIRO), off North West Shelf, north-western Australia aboard the R.V. *Soela*, and in the Gulf of Carpentaria, using the R.V. *Southern Surveyor*. These have been supplemented by additional material in the Queensland and Northern Territory Museum collections. The North West Shelf was investigated using a beam trawl and epibenthic sledge, and the results of the analysis of the structure of the decapod community have been reported by Ward & Rainer (1988).

There has been relatively little work on the Indo-West Pacific Parthenopidae, with Flipse (1930) still being the single most important reference. Miers (1879), Haswell (1879), and Campbell & Stephenson (1970), have made the most significant contributions to our knowledge of the Australian fauna. Very little is known of the rich group of tropical parthenopid species.

Abbreviations used in the text are: c.b., carapace breadth; c.l., carapace length; G1, first male gonopod; NHM, The Natural History Museum, London; NTM, Northern Territory Museum, Darwin; QLD, Queensland, Australia; QM, Queensland Museum, Brisbane. Measurements given in the text are of the carapace breadth (measured at the widest point) followed by length.

SYSTEMATICS

KEY TO AUSTRALIAN SPECIES OF *CRYPTOPODIA*

1. Carapace with cardio-intestinal region relatively flat, and laterally demarcated by long, narrow, very deep grooves so as to appear lyre-shaped *C. dorsalis* White & Adams, 1847
Cardio-intestinal region separated by broad shallow depressions; cardiac region more-or-less elevated 2
2. Carapace with margins strongly serrated and spinous
 *C. angulata* H. Milne Edwards & Lucas, 1841
Carapace sometimes with anterolateral margins moderately spinous, but posterior margin at most crenellated 3
3. Third maxilliped noticeably swollen, with conspicuous, broad, flattened granules on inner margin of ischium which may extend over the entire outer surface *C. pan* Laurie, 1906
Third maxilliped not swollen 4
4. Carapace surface relatively smooth except for slightly granular crests; shallow gastric depression centrally; presence of closed fissures radiating in from margins visible dorsally
 *C. queenslandi* Rathbun, 1918
Carapace surface more-or-less coarsely granulated and pitted; deep gastric depression centrally; marginal closed fissures not obvious dorsally 5
5. Carapace with margins of rostrum subparallel over proximal half; branchial, cardiac, and gastric regions strongly inflated
 *C. fistulosa* Chiong & Ng, 1994

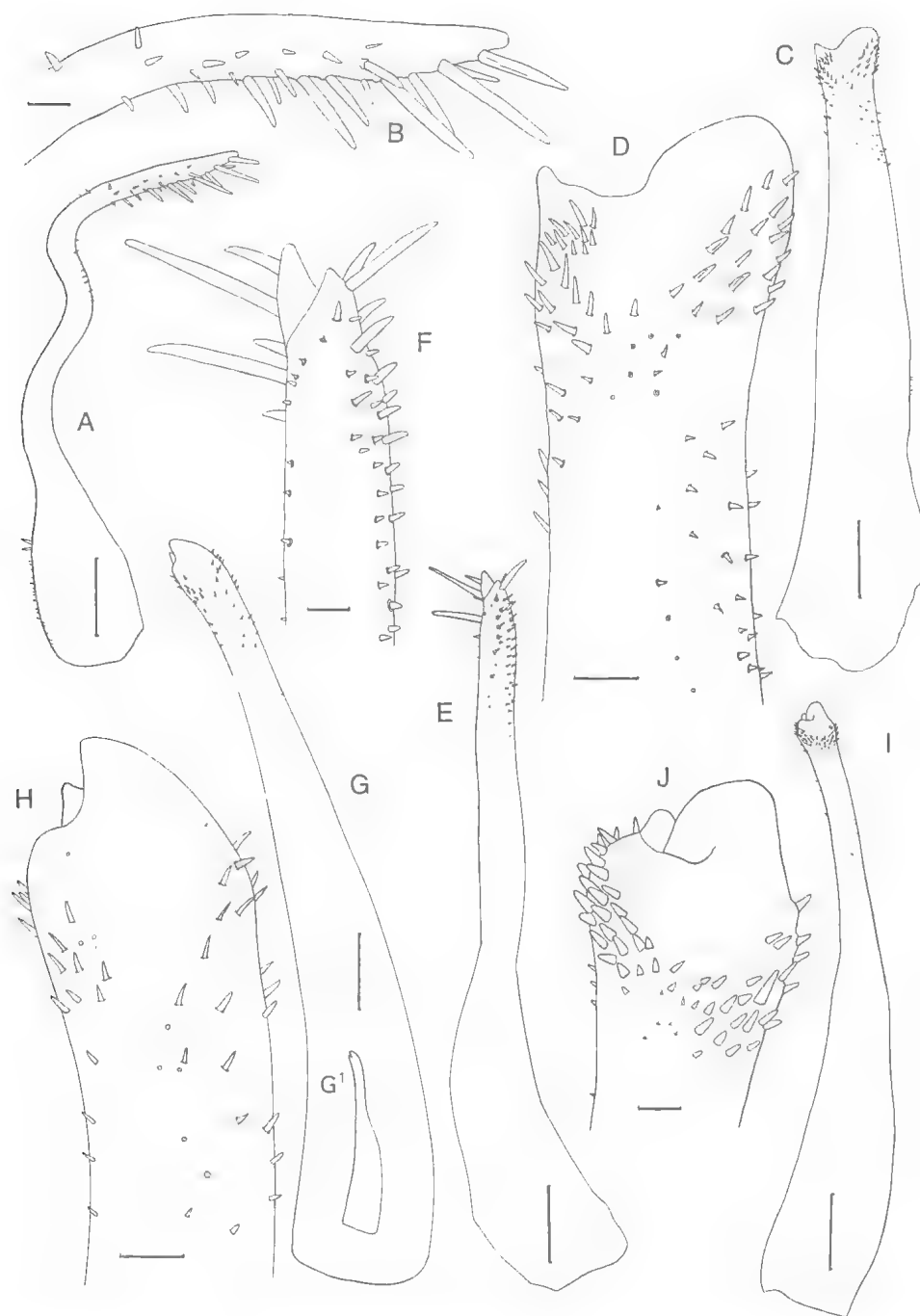


FIG. 1. Male first gonopods of *Cryptopodia* species, showing entire view and magnified view of apex. A, B, C. *pan* (QMW18473). C, D, *C. queenslandi* (QMW18981). E, F, *C. angulata* (QMW18306). G, G¹ (rotated view). H, *C. fistulosa* (QMW18980). I, J, *C. dorsalis* (QMW18291). Scale line: A, C, E, G=0.05mm. D, B, F, H, J=0.01mm; I=0.10mm.

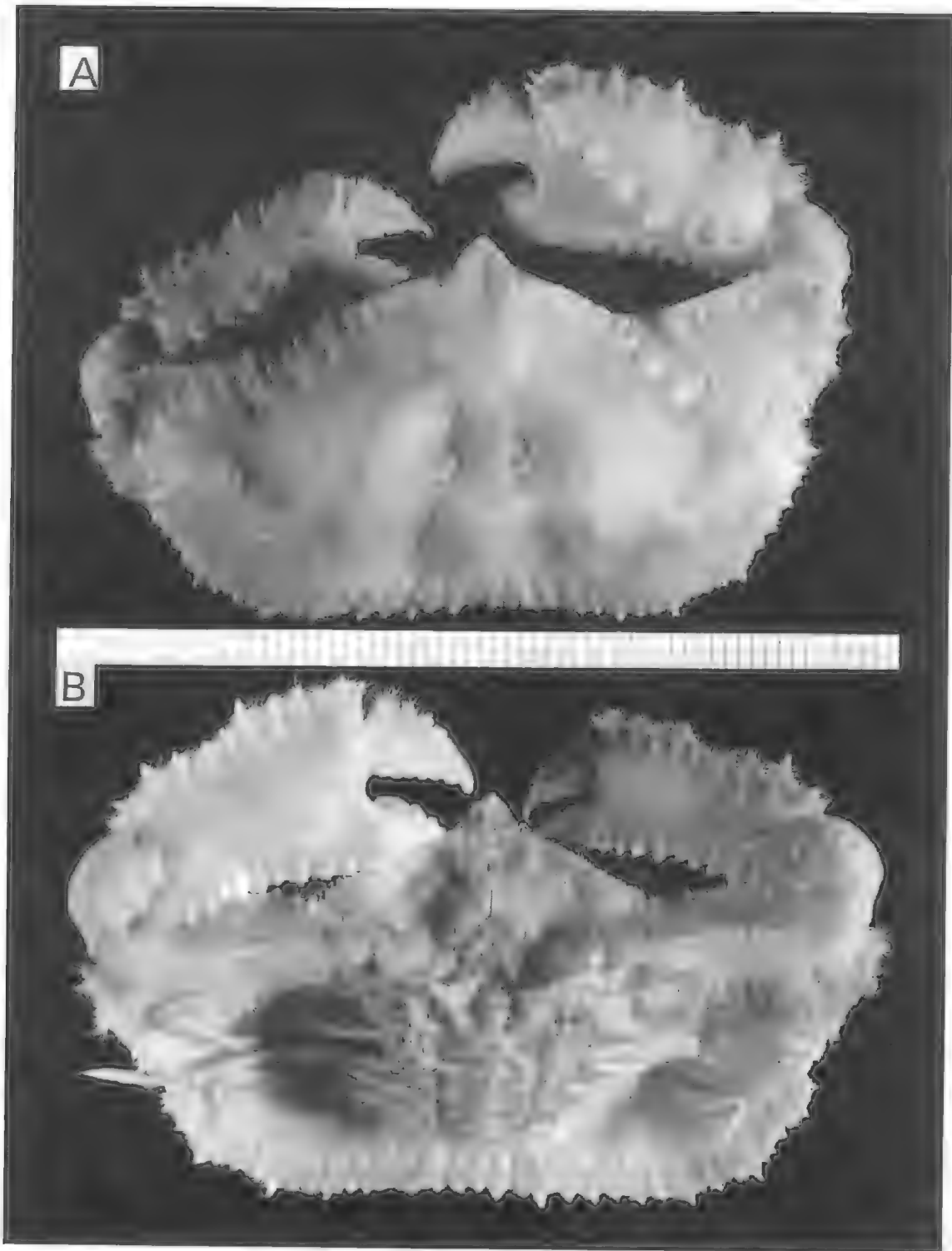


FIG. 2. *Cryptopodia angulata* H. Milne Edwards & Lucas, 1841 (QMW18299). A, dorsal view. B, ventral view. Scale line in mm.

Carapace with margins of rostrum tapering from the base; branchial, cardiac, and gastric regions not strongly inflated

..... *C. spatulifrons* Miers, 1879

Cryptopodia angulata

H. Milne Edwards & Lucas, 1841

(Figs 1E, F; 2A, B)

Cryptopodia angulata H. Milne Edwards & Lucas, 1841: 481, pl. 28, figs 16-19; Alcock, 1895: 282; Chopra, 1935: 473; Chhappgar, 1957: 415, pl. 4; Ahmad et al., 1973: 15 (listed); Tirmizi, 1980: 107 (listed); Tirmizi & Kazmi, 1983: 369 (listed); 1991: 211-213; Banu & Nurul Huda, 1989: 646-647.

Cryptopodia angulata var. *cippifer* Alcock 1895: 283; Flipse, 1930: 62, 82.

MATERIAL EXAMINED

CSIRO, F.R.V. *Southern Surveyor*, Gulf of Carpentaria: QMW18305, ♂ (34.2 x 20.2mm), 13°02'S, 139°22.2'E, Stn 36, 58m, 24.11.1991. QMW18306, ♂ (21.9 x 14.1mm), 13°25.6'S, 138°36.0'E, Stn 34, 54m, 24.11.1991. QMW18298, ♀ (38.2 x 22.2mm), 14°00.7'S, 139°11.6'E, Stn 35, 59m, 28.11.1990. QMW18299, ♂ (37.1 x 22.8mm), ♀ (54.6 x 30.2mm), 13°28.9'S, 139°11.9'E, Stn 34, 57m, 28.11.1990. QMW17334, ♂ (37.8mm c.b., rostrum damaged), 14°27.4'S, 138°11.9'E, Stn 20, 52m, 25.11.1990.

OTHER MATERIAL: NTM Cr000902, 2♀ (37.3 x 22.1, 51.5 x 28.2mm), Arafura Sea, 12°58.0'S, 132°10.0'E, Stn HL, 81-82, 27m, 19.10.81, R.V. *Gemini*.

REMARKS

The present study greatly extends the previously known range of *C. angulata*. Specimens collected from the Gulf of Carpentaria, apart from a few minor differences, correspond closely with the descriptions of Milne Edwards & Lucas (1841) and Alcock (1895). The triangular gastric depression, noted by Alcock (1895) as being 'very deep', appears to be variable in depth: in our specimens it is moderately deep, but Chopra (1935) found it to vary from more or less shallow to quite deep. On our specimens the border of this depression had, in most cases, a tubercle at each branchial angle and, less frequently, two small tubercles side by side on the anterior angle of the depression. No tubercles were present on the summit of the cardiac region. Chopra (1935) and Tirmizi & Kazmi (1991) found this tuberculation to be variable, with one small individual examined by Chopra bearing small spines instead of tubercles. However, none of the specimens examined by Chopra (1935), Tirmizi & Kazmi (1991), nor ourselves had 'large, erect definitely-placed

spines', as described by Alcock (1895), for *C. angulata* var. *cippifer*.

Alcock described the rostrum as ending in a sharp point; the rostra of the specimens detailed herein are dome-shaped and end in a relatively blunt point. A dome-shaped rostrum was found in a male specimen by Tirmizi & Kazmi (1991).

Alcock (1895) pointed to the presence of spines on the meri of the ambulatory legs. This spination is present on our specimens but only on the first and last pair of legs. Tirmizi & Kazmi (1991) described an identical pattern of spination to that in our specimens.

Granulation on the carpus of the chelipeds was variable among the specimens examined by Chopra (1935), but showed little variation among the specimens of Tirmizi & Kazmi (1991). Most of Chopra's (1935) specimens were either smooth or slightly granular, as described for *C. angulata* var. *cippifer*, by Alcock (1895). Alcock's (1895) comparison of *C. angulata* and its variety suggests that there was no granulation on the carpi of the chelipeds of his specimens of *C. angulata*. The diagram of Tirmizi & Kazmi (1991) shows more granular carpi than those of either Chopra's (1935), or our specimens. Banu & Nurul Huda (1988) reported the presence of a granular carpus for a specimen collected off Penang Island, Malaysia, whereas a number of specimens collected by the same authors from the Chittagong Coast bordering Bangladesh possessed smooth carpi. There is only a small amount of carpal granulation among our specimens. Granulation is more evident on the ventral surface of the carpus. On two of our specimens, a male and a female, there is a small, sharp, sub-distal, median spine on the upper surface of the carpus. This replaces a small tubercle in the other specimens. No mention of this character is made by other authors for *C. angulata*.

The status of *Cryptopodia angulata* var. *cippifer* Alcock, 1895, is still uncertain. The other character used by Alcock (1895) to separate *C. angulata* var. *cippifer* from *C. angulata*, is the presence of prominent spines surrounding the central depression. Evidence from Chopra (1935), Tirmizi & Kazmi (1991), and this study, suggests a degree of intraspecific variation that may encompass most of the characteristics described by Alcock (1895) for *C. angulata* var. *cippifer*. It is probable that *C. angulata* var. *cippifer* is a junior synonym of *C. angulata*, but examination of Alcock's type specimens along with a large series of specimens from across the range

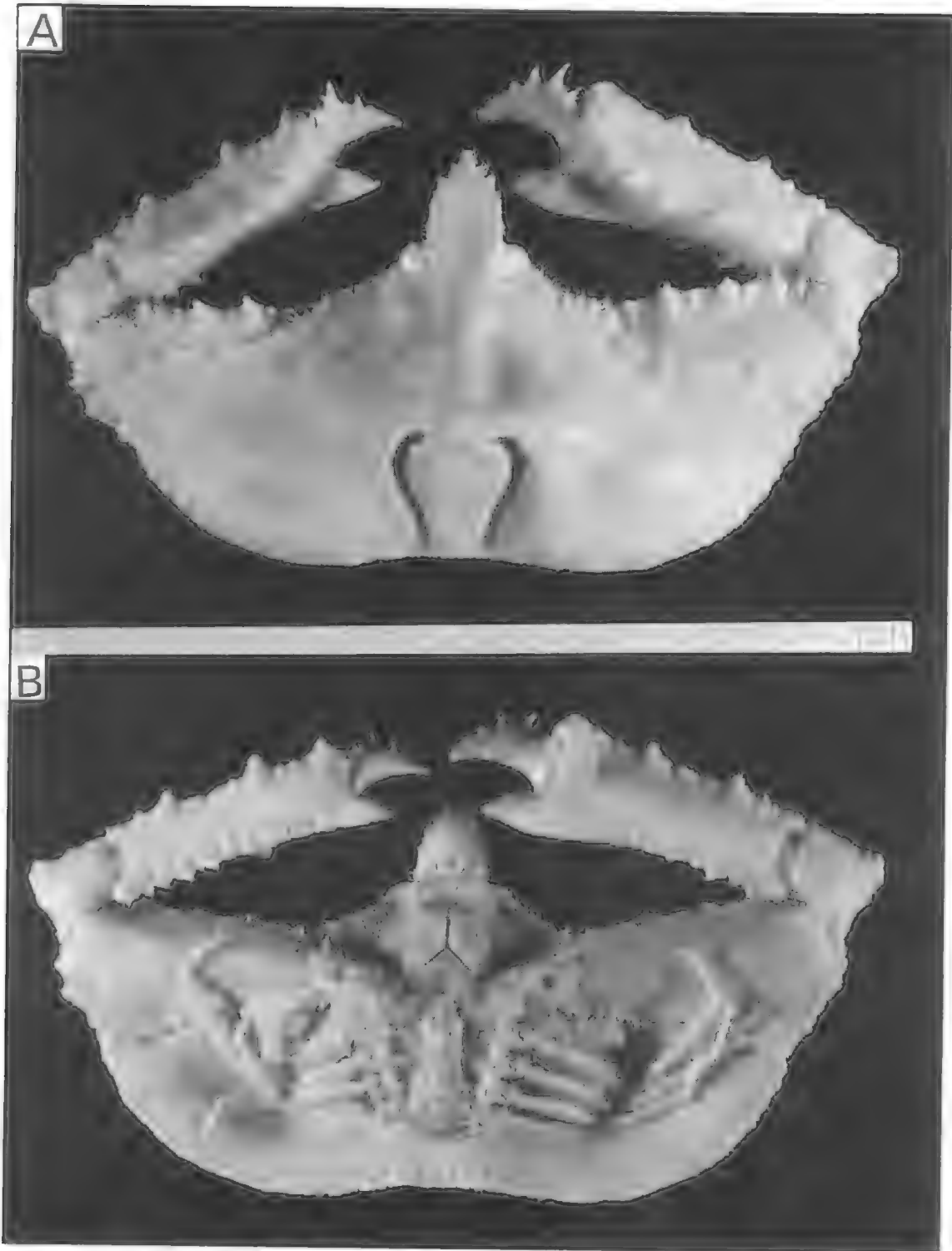


FIG. 3. *Cryptopodia dorsalis* White & Adams, 1847 (QMW18297). A, dorsal view. B, ventral view. Scale line in mm.



FIG. 4. *Cryptopodia pan* Laurie, 1906 (QMW18461). A, dorsal view. B, ventral view. Scale line in mm.

of occurrence of *C. angulata* is required for final certainty.

DISTRIBUTION

C. angulata: Type locality unknown; Karachi; west coast of India; Malabar Coast, Orissa Coast, Sandheads at mouth of Hugli River, India; Ceylon; Malaysia; and now northern Australia, from the Arafura Sea to the Gulf of Carpentaria. *C. angulata* var. *cippifer* is only known from Karachi, Pakistan (type locality). Bathymetric range: 52 to 59m.

Cryptopodia dorsalis

White & Adams, 1847 (in White, 1847)
(Figs 1 I, J; 3A, B)

Cryptopodia dorsalis White & Adams, 1847, in White, 1847a: 125 [nomen nudum]; 1847b: 84; White, 1847c: 205; Adams & White, 1848: 30, pl. 6, fig. 5; Flipse, 1930: 63, 82.

MATERIAL EXAMINED

CSIRO, R.V. *Soela*, North West Shelf: QMW18290, ♂ (62.3 x 35.3mm), 19°29.6'S, 118°52.2'E, Stn 05D03BT, 40m, 25.10.1983. QMW18291, ♂ (64.5 x 35.8mm), 19°58.6'S, 117°49.4'E, Stn 03D09BT, 43m, 26.06.1983. QMW18292, ♂ (17.1 x 11.4mm), 19°56.8'S, 117°53.5'E, Stn 03B02BT, 44m, 25.06.1983. QMW18293, ♂ (16.2 x 10.6mm), 19°45.7'S, 117°52.0'E, Stn 01B13BT, 54m, 20.02.1983. QMW18294, ♂ (20.8mm c.l., lateral margin broken), 19°03.6'S, 119°03.4'E, Stn 05B12BT, 82m, 23.10.1983. QMW18295, ♂ (25.1 x 15.5mm), 19°59.2'S, 117°03.6'E, Stn 04B18BT, 52m, 05.09.1983. QMW18296, ♂ (11.4 x 8.0mm), 19°30.8'S, 118°49.1'E, Stn 03B07S, 37-38m, 28.06.1983. QMW18478, ♂ (11.3 x 7.8mm), ♀ (16.0 x 11.6mm), 19°30.6'S, 118°49.4'E, Stn 03B07BT, 37-38m, 28.06.1983. QMW18552, ♂ (14.7mm c.l., lateral margin damaged), 19°30.8'S, 118°49.3'E, Stn 04B07BT, 38-39m, 30.08.1983. QMW18289, 2♂ (62.3 x 35.8, 22.4 x 16.4mm), 19°55.5'S, 117°55.5'E, Stn 02B03BT, 42m, 22.04.1983. QMW18288, ♂ (18.0 x 11.5mm), 19°54.6'S, 117°56'E, Stn 01B03S, 44m, 18.02.1983. QMW18287, ♀ (73.6mm c.b., rostrum broken), 19°55.9'S, 117°55.5'E, Stn 03B03BT, 42-43m, 26.06.1983.

OTHER MATERIAL: QMW18297, ♂ (61.1 x 35.3mm), Arafura Sea, 12°15.6'S, 129°15'E, Stn 508, 29m, 17.11.1989, Bureau Rural Resources. QMW12771, ♂ (76.3 x 42.4mm), N. of Cape Bowling Green, 19°08.9'S, 147°23.3'E, 09.05.1985, C. Jones, Qld. Fisheries Service.

REMARKS

The authorship of this species has been attributed to Adams & White, 1847, by Flipse (1930)

in his major revision of the Parthenopidae; however the first valid citation in White (1847b) puts the authorship as White & Adams (the very first mention of the name occurred in White (1847a) but was a nomen nudum). This species was listed as new in four separate publications, and there is some difficulty in being certain which of the two descriptions that appeared in 1847 has nomenclatural priority. Apparently the first to appear was the article in the 1847 *Proceedings of the Zoological Society of London*. This volume, according to the date stamp of the British Museum Library, was not available until July, 1848, but according to Sclater (1893) the journal was published in separate sheets prior to binding, and White's article on pp. 84-86, appears with sheet cixxv which was delivered from the printers to the Zoological Society on 20 July 1847. White (1847c), as cited here, was date stamped "47.9.22.5" by the British Museum Library and therefore was available only later in September, 1847. There could be some dispute as to whether the earlier published work was distributed, and thus available, prior to the second that appeared in September, but this will probably never be known, and thus I choose to cite the publications in order of their known printing dates. *Cryptopodia dorsalis* is also described in Adams & White's 1848 report of the 'Voyage of the *Samarang*', and in this, authorship is reversed and given as Adams & White.

The distribution of *C. dorsalis* suggests that it is common throughout the waters of northern Australia and the Indonesian Archipelago. There is little doubt as to the correct identification of this species, given the presence of two deep, lyre-shaped grooves which border the lateral edges of the cardiac region, a character unique to *C. dorsalis*.

DISTRIBUTION

Sulu Sea (type locality); northern Australia, from the North West Shelf, Arafura Sea, and north of Cape Bowling Green (Townsville). Bathymetric range: 29 to 82m.

Cryptopodia pan Laurie, 1906 (Figs 1A, B; 4A, B)

Cryptopodia pan Laurie, 1906: 392, fig. 4, pl. 1, fig. 6; Rathbun, 1911: 259; Flipse, 1930: 63, 78, 82; Tan & Richer de Forges, 1993: 131, figs 6E, F.

MATERIAL EXAMINED

CSIRO, R.V. *Soela*, North West Shelf: QMW18474, 2♀ (10.1 x 7.9; 10.6 x 8.0mm), 20°00.2'S, 117°00.5'E, Stn 01B17BT, 53m, 22.02.1983. QMW18476, ♂



FIG. 5. *Cryptopodia queenslandi* Rathbun, 1918 (QMW18309). A, dorsal view. B, ventral view. Scale line in mm.



FIG. 6. *Cryptopodia queenslandi* Rathbun, 1918, spotted variant (QMW18981): A, dorsal view. B, ventral view. Scale line in mm.

(14.2mm c.b., rostrum damaged), 19°03.6'S, 119°00.6'E, Stn 01B11BT, 81m, 13.02.1983. QMW18464, ♂ (23.8mm c.b., rostrum damaged), 19°57.9'S, 117°49.3'E, Stn 03D07BT, 40m, 26.06.1983. QMW18465, ♂ (15.5 x 11.7mm), 19°03.2'S, 119°02'E, Stn 06B12TN, 78-80m, 11.12.1982. QMW18466, ♀ (14.6 x 11.1mm), 19°29.4'S, 118°51.5'E, Stn 05D07BT, 40m, 25.10.1983. QMW18467, ♂ (22.1 x 15.1mm), 19°04.6'S, 118°57.9'E, Stn 03B10BT, 81-82m, 30.06.1983. QMW18468, ♂ (15.1 x 11.0mm), 19°30'S, 118°52'E, Stn 05D05S, 36-37m, 25.10.1983. QMW18469, 2♂ (22.3 x 15.3; 10.2 x 8.1mm), 20°00.4'S, 117°00.4'E, Stn 04B17BT, 52m, 04.09.1983. QMW18470, ♀ (14.8 x 10.8mm), 19°05.3'S, 118°54.0'E, Stn 03B04BT, 82m, 29.06.1983. QMW18471, ♀ (12.7 x 10.7mm), 18°59.1'S, 118°45.9'E, Stn 06B05TN, 84m, 07.12.1982. QMW18472, 1 juv. (7.1 x 6.6mm), 19°42.0'S, 117°57'E, Stn 01B15S, 56m, 20.02.1983. QMW18473, ♂ (23.4 x 16.6mm), 19°24.8'S, 118°57.6'E, Stn 06B08TN, 47-48m, 08.12.1982. QMW18475, ♀ (13.1mm c.l., lateral margin damaged), 19°59.1'S, 117°51.6'E, Stn 04B01BT, 42m, 27.08.1983. QMW18463, ♀ (carapace damaged), 19°56.7'S, 117°53.6'E, Stn 05B02BT, 40m, 26.10.1983. QMW18462, ♂ (21.0 x 14.2mm), 19°04.9'S, 118°50.6'E, Stn 05B05BT, 81m, 30.10.1983. QMW18461, ♂ (13.8 x 10.2mm), ♀ (17.1 x 12.7mm), 19°05'S, 118°50.5'E, Stn 03B05BT, 83-84m, 29.06.1983.

REMARKS

This study, and that of Tan & Richer de Forges (1993), greatly extends the known distribution of this species. Our specimens agree closely with the description of Laurie (1906). In many specimens, the exposed surface of the ischium of the third maxilliped is completely covered in large, squamous granules, and in a few specimens, the granules are more or less coalesced over the outer two-thirds. This differs from Laurie's (1906) type description, where he said that only the inner third of the ischium is covered in such granules.

DISTRIBUTION

Sri Lanka (type locality); northern Australia, from the North West Shelf; New Caledonia. Bathymetric range: 28 to 84m.

Cryptopodia queenslandi Rathbun, 1918 (Figs 1C, D; 5A, B; 6A, B, 7A, B)

Cryptopodia fornicata: Haswell, 1879: 454, 1882: 37 [not *C. fornicata* (Fabricius, 1781)].

Cryptopodia queenslandi Rathbun 1918: 26, pl. 12.

Cryptopodia fornicata var. *queenslandi*: Flipse, 1930: 65-66, 78, 82.

MATERIAL EXAMINED

CSIRO, R.V. *Soela*, North West Shelf: QMW18322, ♀ (22.8 x 15.7mm), 19°29.8'S, 118°52.3'E, Stn 05D08BT, 37-38m, 25.10.1983. QMW18323, ♂ (17.1 x 11.2mm), 19°29.4'S, 118°52.1'E, Stn 02B08BT, 38-39m, 26.04.1983. QMW18324, 3♂ (16.0 x 10.9-24.3 x 15.7mm), 3♀ (16.8 x 11.0 - 30.6 x 20.1mm), 19°30.8'S, 118°49.3'E, Stn 04B07BT, 38-39m, 30.08.1983. QMW18325, ♂ (24.5 x 15.5mm), 19°28.4'S, 118°55.2'E, Stn 04B09BT, 39m, 31.08.1983. QMW18326, ♂ (17.4 x 11.4mm), 2♀ (18.1 x 11.7; 13.0 x 8.7mm), 19°30.6'S, 118°49.4'E, Stn 03B07BT, 37-38m, 28.06.1983. QMW18327, 4♂ (22.5 x 14.7 - 37.6 x 22.7mm), 2♀ (37.3 x 23.6; 40.8 x 24.6mm), 19°29.4'S, 118°52.4'E, Stn 05D02BT, 37-38m, 24.10.1983. QMW18328, 2♂ (33.5 x 20.6; 33.5 x 20.3mm), 2♀ (22.5 x 14.7; 20.7 x 13.7mm), 19°29.5'S, 118°52.2'E, Stn 05D01BT, 37m, 24.10.1983. QMW18329, 2♂ (16.4 x 11.3; 13.3 x 12.4mm), 2♀ (16.8 x 11.1; 20.2 x 12.5mm), 19°28.1'S, 118°55.2'E, Stn 03B09BT, 38-40m, 28.06.1983. QMW18330, ♀ (11.7 x 8.1mm), 19°30.9'S, 118°48.7'E, Stn 02B07BT, 39-40m, 26.04.1983. QMW18331, 4♀ (8.4mm c.l., lateral margin damaged; 10.2 x 7.2mm; 8.1mm c.l., lateral margin damaged; 10.8 x 7.6mm), 19°28.6'S, 118°55'E, Stn 02B09S, 38-40m, 26.04.1983. QMW18332, ♂ (7.5mm c.l., lateral margin damaged), 19°55.5'S, 117°55.5'E, Stn 02B03BT, 42m, 22.04.1983. QMW18333, 2♀ (11.4 x 7.9mm; 11.2 x 7.9mm), 19°29.9'S, 118°52'E, Stn 02B08S, 38-39m, 26.04.1983. QMW18334, ♀ (carapace damaged), 19°58.3'S, 117°49.4'E, Stn 03D01S, 43m, 25.06.1983. QMW18335, 3 juveniles (3.1 x 2.6 - 5.1 x 4.9mm), 19°29.3'S, 118°52.6'E, Stn 01B08RevS, 36m, 15.02.1983. QMW18336, 1 juvenile (5.1 x 4.5mm), 19°58.9'S, 117°51.7'E, Stn 04B01S, 42m, 27.08.1983. QMW18337, ♀ (8.2 x 6.0mm), 19°58.1'S, 117°49.2'E, Stn 03D07S, 40m, 26.06.1983. QMW18338, 2 juveniles (4.9 x 4.0; 3.3 x 3.0mm), 19°29'S, 118°53.5'E, Stn 01B08S, 40m, 12.02.1983. QMW18312, 3♂ (7.8 x 6.0 - 26.4 x 16.7mm), 5♀ (10.0 x 7.1 - 24.3 x 15.1mm), 19°30.9'S, 118°48.7'E, Stn 02B07BT, 39-40m, 26.04.1983. QMW18313, ♀ (32.0 x 20.6mm), 19°53.1'S, 118°03.9'E, Stn 06B01S, 36-38m, 05.12.1982. QMW18314, 2♂ (20.2mm c.l., lateral margin damaged; carapace damaged), 19°29.9'S, 118°52.0'E, Stn 05D01S, 37m, 24.10.1983. QMW18315, ♂ (23.1 x 15.1mm), 2♀ (26.9 x 17.4; 20.7 x 13.4mm), 19°30.9'S, 118°49.2'E, Stn 05B07BT, 38-39m, 25.10.1983. QMW18316, ♀ (16.5 x 11.9mm), 19°56.7'S, 117°53.6'E, Stn 05B02BT, 40m, 26.10.1983. QMW18317, ♂ (37.2 x 22.9mm), 2♀ (21.2 x 15.0; 22.4 x 14.4mm), 19°29.4'S, 118°52.4'E, Stn 05D09BT, 38m, 25.10.1983. QMW18318, ♂ (25.5 x 16.7mm), 19°29.6'S, 118°52.2'E, Stn 04B08BT, 38-39m, 30.08.1983. QMW18319, ♀ (16.1 x 10.9mm), 19°56.8'S, 117°53.5'E, Stn 03B02BT, 44m, 25.06.1983. QMW18320, ♀ (14.0mm c.l., lateral margin damaged), 19°55.6'S, 117°56.0'E, Stn 04B06BT, 43-44m, 26.08.1983. QMW18321, ♂ (17.5 x

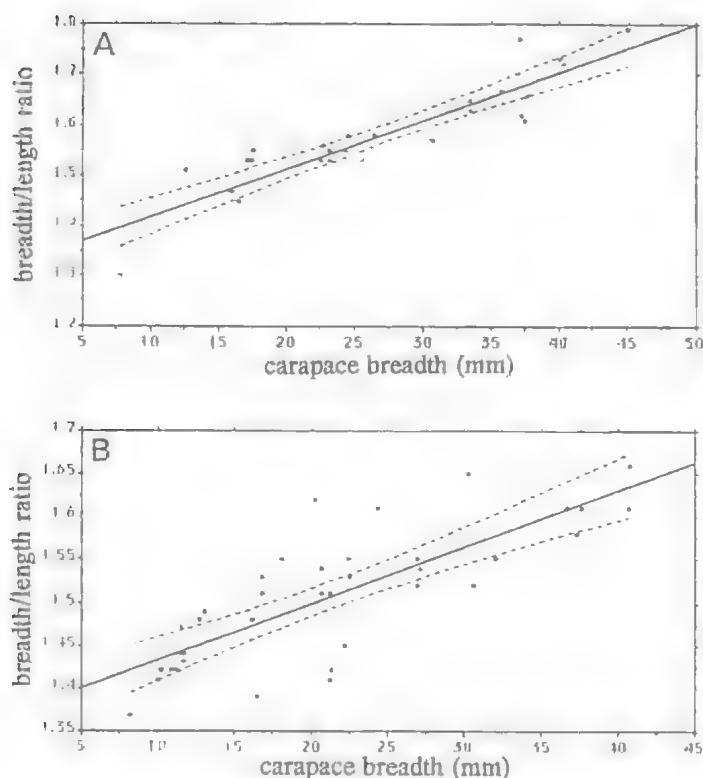


FIG. 7. Allometric growth equations for *C. queenslandi*. A, males: $y=0.1x+1.32$, $r^2=0.82$, $n=27$. B, females: $y=0.007x+1.37$, $r^2=0.63$, $n=37$. Dashed lines represent the 95% confidence interval for the true mean of y .

11.3mm), 19°30.8'S, 118°49.1'E, Stn 03B07S, 37-38m, 28.06.1983.

CSIRO, R.V. *Southern Surveyor*, Gulf of Carpentaria: QMW18307, ♂ (35.8 x 21.5mm), 13°40.1'S, 136°45.6'E, Stn 30, 22m, 23.11.1991. QMW18309, 2♂ (45.0 x 25.1; 40.3 x 23.4mm), 10°52.6'S, 136.12.1'E, Stn 12, 42m, 21.11.1991. QMW18308, ♀ (21.3 x 15.0mm), 10°57.6'S, 140°23'E, Stn 58, 54m, 29.11.1991. QMW18310, ♀ (36.7 x 22.8mm), 11°50.8'S, 136°33.9'E, Stn 4, 33m, 18.11.1991. QMW18311, 2♀ (40.7 x 25.2; 26.9 x 17.7mm), 13°02.8'S, 141°27.7'E, Stn 45, 21m, 26.11.1991. QMW18300, ♂ (26.2mm c.l., lateral margin damaged), 11°58.5'S, 140°41.4'E, Stn 63, 53m, 04.12.1991. QMW18301, ♂ (21.9mm c.l., lateral margin damaged), 10°33.4'S, 138°42.6'E, Stn 83, 53m, 09.12.1991. QMW18302, ♂ (40.0 x 23.1mm), 11°09.2'S, 139°41.8'E, Stn 82, 55m, 08.12.1991. QMW18303, ♀ (37.6 x 23.4mm), 15°00.9'S, 140°12'E, Stn 43, 48m, 30.11.1990. QMW18304, 2♂ (30.8 x 19.6mm; 21.4mm c.l., lateral margin damaged), 2♀ (30.3 x 18.4; 27.2 x 17.7mm), 16°01.8'S, 140°11.9'E, Stn 41, 31m, 29.11.1990. QMW17316, ♂ (37.1 x 21.0mm), 14°27.5'S, 138°42'E, Stn 97, 52m,

12.12.1991. QM unreg., ♂ (22.8 x 14.7mm), 143°08.6'S, 11°49.9'E, Stn 007, 22m, 13.1.93.

OTHER MATERIAL: QMW1495, ♂ (48.8 x 28.5mm), Green Island, Moreton Bay, 27°26'S, 153°14'E. QMW18981, ♂ (22.8 x 14.6mm), Shelburne Bay, 11°51.9'S, 143°08.9'E, Stn 7, 22m, 13.01.1993. CSIRO, F.R.V. *Southern Surveyor*.

REMARKS

Flipse (1930) suggested that *C. queenslandi* is a variety of *C. fornicata*. However, there are differences between these two species which warrant *C. queenslandi* being recognised as a separate species from *C. fornicata*. There are significant differences in the male G1. In *C. fornicata*, the apex of the G1 is produced into two nearly symmetrical lobes (Dai & Yang, 1991: fig. 90), whereas in *C. queenslandi*, these lobes are highly asymmetrical, with one being much smaller (Fig. 1C, D). Also, in *C. fornicata*, the G1 tapers more rapidly than in *C. queenslandi*. In these respects, the G1 of our specimens are like those of Campbell & Stephenson (1970), collected from Moreton Bay, Queensland. The chelipeds of *C. fornicata* are considerably less than twice the length

of the carapace (Alcock, 1895), whereas in *C. queenslandi* they are twice the length (Rathbun, 1918). On average, *C. fornicata* appears to be a larger species, with the specimens examined by Dai & Yang (1991) being 34% larger than the largest crabs (females and males) examined in this paper. Considering the large amount of material available for our study this seems significant. Rathbun's (1918) adult male holotype of *C. queenslandi* was 28% smaller than that of Dai & Yang's (1991) specimen. The only specimens of *C. queenslandi* that approach the size of Dai & Yang's (1991) specimen are those described by Flipse (1930) from Indonesia (89% for males and 95% for females); and it would be desirable in a generic revision to check the identity of his specimens.

The degree of concavity of the posterior margin seems unreliable for separating the two species. Rathbun (1918) described the posterior rim of *C. queenslandi* as concave in its middle two-fifths;

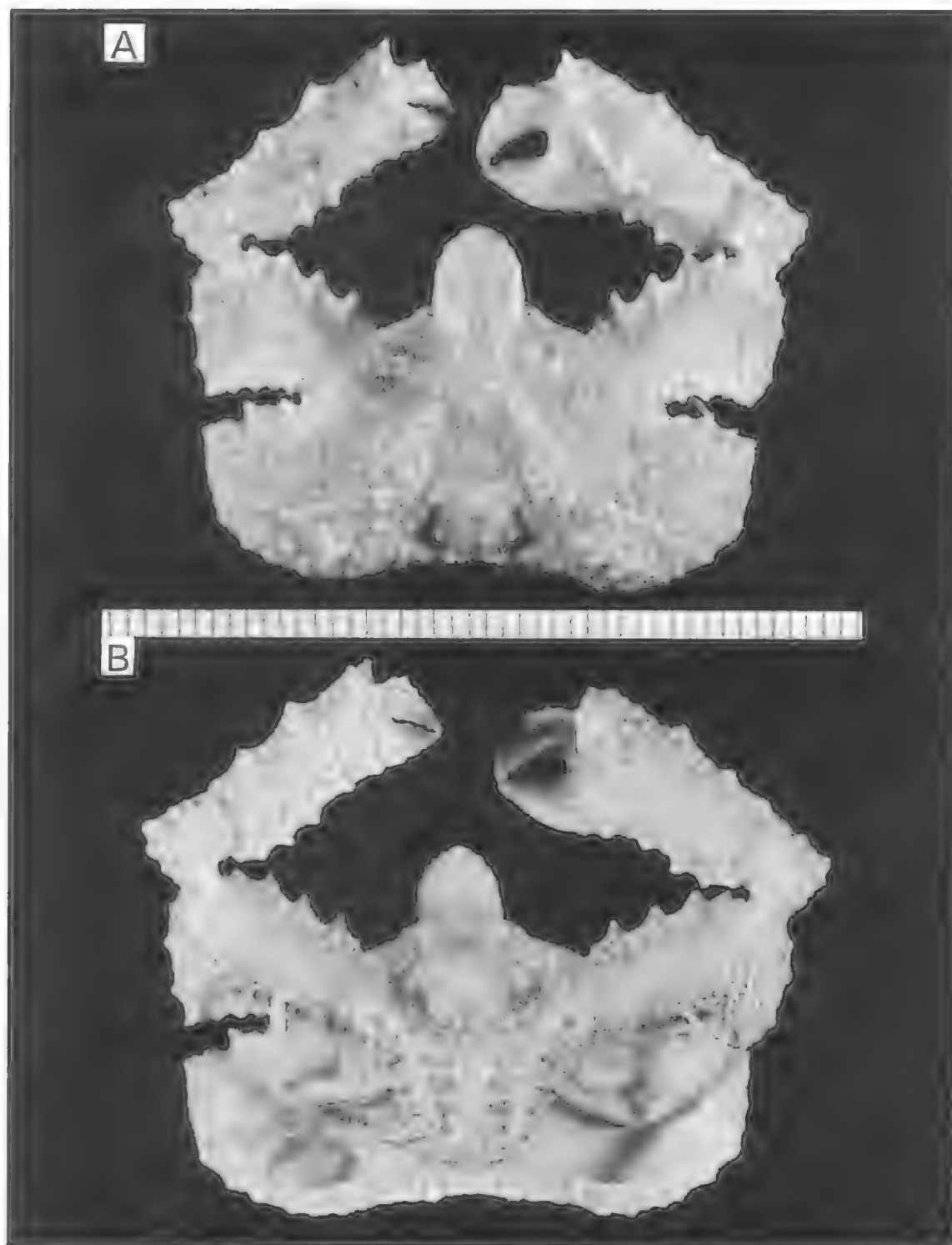


FIG. 8. *Cryptopodia fistulosa* Chiong & Ng, 1994 (paratype, QMW18980): A, dorsal view. B, ventral view. Scale line in mm.



FIG. 9. *Cryptopodia spatulifrons* Miers, 1879, holotype (NHM 1858.172), male first gonopod (left), showing entire view, and magnified ventral and dorsal views. (Taken from Chiong & Ng (1994)).

whereas Flipse (1930) said it was straight or very weakly concave. However, some records have also described or figured specimens of *C. fornicata* as having a convex posterior rim that forms a continuous smooth edge with the antero-lateral margin (eg. Sakai, 1976: 292, text-fig 163, Dai & Yang, 1991).

Flipse (1930) described *C. fornicata* as being 1.5 times as wide as long, and *C. queenslandi* as being twice as wide as long. Dai & Yang (1991) described *C. fornicata* as being 1.6–1.8 times as wide as long, while the specimen examined by

Rathbun (1918), a male, had a ratio of 1.8. We have plotted length against breadth for the specimens in this study (Fig. 7A, B); and there is distinct allometric growth with the length/breadth ratio ranging from 1.35 in the smallest specimens, to c. 1.8 in the largest. This is discussed further later. Therefore we disagree with Flipse (1930) that the simple breadth/length ratio is useful in separating the two species.

C. queenslandi normally has no obvious dorsal patterning, but an unusual specimen from the Gulf of Carpentaria (♂, 22.8 mm c.b., QMW18981), bears numerous spots over the entire dorsal surface (Fig. 6). Morphologically it cannot be separated. Dr P.K.L. Ng has informed us that juvenile *C. fornicata* have a striking colour pattern that is absent in adults, however while there were many smaller specimens in the present series, only the individual above showed the distinctive pattern described.

C. queenslandi appears to be restricted to waters around northern Australia and possibly Indonesia, whereas *C. fornicata*, as reported by Sakai (1976), is found in Sagami Bay, Japan; China Sea; the Philippines; the Gulf of Thailand; Singapore; and westward to the Gulf of Mattaban; Andaman Sea; Sri Lanka; Palk Straits; and the Persian Gulf. We believe Haswell (1880) incorrectly identified *C. fornicata* from Port Denison, north Queensland, and that his specimens were most likely *C. queenslandi*.

Allometric growth: Allometric growth has been reported in the Parthenopidae previously by Gore & Scotto (1983). As we had an abundance of specimens of *C. queenslandi* we did a simple plot of length/breadth ratios. Fig. 7A, B shows the linear relationship between carapace length and breadth for male and female *C. queenslandi*, respectively. Both diagrams display statistically significant allometric growth for both sexes ($r^2=0.821$ (males) and $r^2=0.63$ (females), $p<0.05$). The correlation coefficients for both sexes are not significantly different ($p>0.05$). However, males broaden to a significantly greater extent than females with increasing size ($p<0.05$).

DISTRIBUTION

Cape Gloucester, Bowen, Queensland (type locality); Java Sea; North West Shelf; Arnhem Bay (Northern Territory); Torres Strait, Shelburne Bay and Palm Island (north Queensland); Moreton Bay (southeast Queensland); Woody Head (northern New South Wales). Bathymetric range: 21–55m.



FIG. 10. *Cryptopodia spatulifrons* Miers, 1879 (Holotype ♂, NHM1858.172, 48.8 mm c.b.): A, dorsal view. B, ventral view.

***Cryptopodia fistulosa* Chiong & Ng, 1994**
(Figs 1G, H; 8A, B)

Cryptopodia spatulifrons: Miers, 1884: 203-204 (specimen from Thursday Island) [not *C. spatulifrons* Miers, 1879].

Cryptopodia fistulosa Chiong & Ng, 1994: 952-957, figs 1A, 2A, 3A, 4A, 5A, C, D, G, H.

MATERIAL EXAMINED

CSIRO, R.V. *SOELA*, NORTH WEST SHELF: QMW18995, ♀ (23.8 x 16.1mm), 19°55.2'S, 117°56.0'E, Stn 05B03BT, 40m, 26.10.1983. QMW18980, ♂ (33.3 x 21.3mm), 19°28.4'S, 118°55.2'E, Stn 04B09BT, 39m, 31.08.1983. QMW18994, ♂ (16.1 x 11.3mm), 20°00.2'S, 117°00.5'E, Stn 04B17S, 52m, 04.09.1983.

REMARKS

This recently described species is very similar in general appearance to *C. spatulifrons* Miers, 1879. The two species can be separated using the key provided in the present paper, but Chiong & Ng (1994) should be consulted for a full list of characters by which they differ.

DISTRIBUTION

Northern Australia, from Shark Bay, W.A. to Torres Strait, northern Queensland. Bathymetric range: 5-52m.

***Cryptopodia spatulifrons* Miers, 1879**
(Figs 9A-C, 10A, B)

Cryptopodia spatulifrons Miers, 1879: 26, pl.5, fig. 10; Haswell, 1879: 454; 1882: 37; Ortmann 1894: 48; Flipse, 1930: 63, 78, 82; Chiong & Ng, 1994: 950-952, figs 1B, 2B, 3B, 4B, 5B, E, F, I, J.

REMARKS

This endemic Australian species is only known with certainty from two specimens, and no new material has been examined as part of this study. The species was redescribed by Chiong & Ng (1994).

DISTRIBUTION

Shark's Bay, Western Australia (type locality); North West Shelf; Prince of Wales Channel, Torres Strait (Miers, 1884); Questionably from Port Jackson (Haswell, 1880). Bathymetric range: 13m (Miers, 1884).

ACKNOWLEDGEMENTS

Dr Peter Ng of the Zoology Department, National University of Singapore, is gratefully thanked for sending us photographs of the holotype of *C. spatulifrons*, and for helpful discussions on the manuscript. We are also indebted to Paul Clark of the Natural History Museum, London, for researching the dates of publication of White's papers describing *C. dorsalis*.

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A NEW SPIDER GENUS (ARANEAE: AMAUROBIOIDEA: AMPHINECTIDAE) FROM THE WET TROPICS OF AUSTRALIA

VALERIE TODD DAVIES

Davies, V.T. 1995 12 01: A new spider genus (Araneae: Amaurobioidea: Amphinectidae) from the wet tropics of Australia. *Memoirs of the Queensland Museum* 38(2):463-469. Brisbane. ISSN 0079-8835.

The distribution of 9 species of *Kababina* gen.nov. in the rainforests of the wet tropics region of northern Queensland indicates local species richness and endemism of spiders there. The new species are *K. alta*, *K. aquilonia*, *K. colemani*, *K. covacevichae*, *K. formartine*, *K. inferna*, *K. isley*, *K. superna* and *K. yungaburra*. *Kababina* is provisionally placed in the Amphinectidae. □ *Kababina*, wet tropics, Amphinectidae.

Valerie Todd Davies, Queensland Museum, PO Box 3300, South Brisbane, Queensland 4101, Australia; 21 June 1995.

Many Australian amaurobioid spiders are recognised by their unexceptional appearance; straw-coloured carapace (often with two darker longitudinal bands), abdominal pattern of light spots in a vague chevron pattern, 3 claws and a cribellum. This new genus belongs in a large group of undescribed species with the following further characters; cephalothorax highest in the foveal region, posterior eye row straight or slightly recurved; anterior median eyes reduced. Two retromarginal and two promarginal cheliceral teeth; prolateral filamentous seta at base of fang, longer than other setae. Labium about as long as wide; sternum slightly longer than wide, pointed posteriorly. Legs 4123; notched trochanters. Feathery hairs on legs. Tarsal trichobothria increasing in length distally; bothrium collariform. Tarsal organ slit-like, broadening distally. Epigynum with medial fossa (opening) wider than long; spermathecae posterior or lateral to fossa. Male palp with rounded tegulum; course of sperm duct showing clearly. Membranous conductor; embolus with or without basal embolic apophyses, arising ventrally; without median apophysis. Tibial apophysis branched. Cribellum (two fields) present or absent in females, absent in males; proximal calamistrum with one row of setae. Colulus large when present. Anterior spinnerets largest; two major ampullate spigots of unequal size on anterior spinnerets.

MATERIALS AND METHODS

The spiders have been collected from rainforests in the Wet Tropics region of northeastern Queensland between latitudes 15°48'-17°16'S. Collection methods include litter sieving followed by heat extraction in funnels,

pitfall collection, pyrethrum spraying of fallen logs and hand collecting from under logs and at night.

Notation of spines follows Platnick & Shadab (1975). All material is lodged in the Queensland Museum (QM). Measurements are in millimetres.

ABBREVIATIONS USED

CL, carapace length; CW, carapace width; AL, abdomen length; AW, abdomen width. Eyes: AME, anterior median; ALE, anterior lateral; PME, posterior median; PLE, posterior lateral. Spinnerets: ALS, anterior; PMS, median; PLS, posterior; l, left; r, right.

Collectors: DC, D. Cook; EWQM, Earth-watch/Queensland Museum; GBM, G.B. Monteith; GT, G. Thompson; HJ, H. Janetzki; JC, J. Covacevich; NC, N. Clyde Coleman; RJR, R.J. Raven; VED, V.E. Davies.

SYSTEMATICS

Kababina gen. nov.

TYPE SPECIES

K. alta sp. nov.

DIAGNOSIS

Three-clawed cribellate. Viewed from top, eye-rows slightly recurved; AME reduced (Fig.1B). Sternum pointed posteriorly; endite longer than wide (Fig.1C). Feathery hairs present. Small medial epigynal fossa. Tegulum with prolateral ridge; semicircular embolus and conductor, arising ventro-retrolaterally on tegulum; without median apophysis. Male palpal tibia not much longer than wide; single long seta prolateral

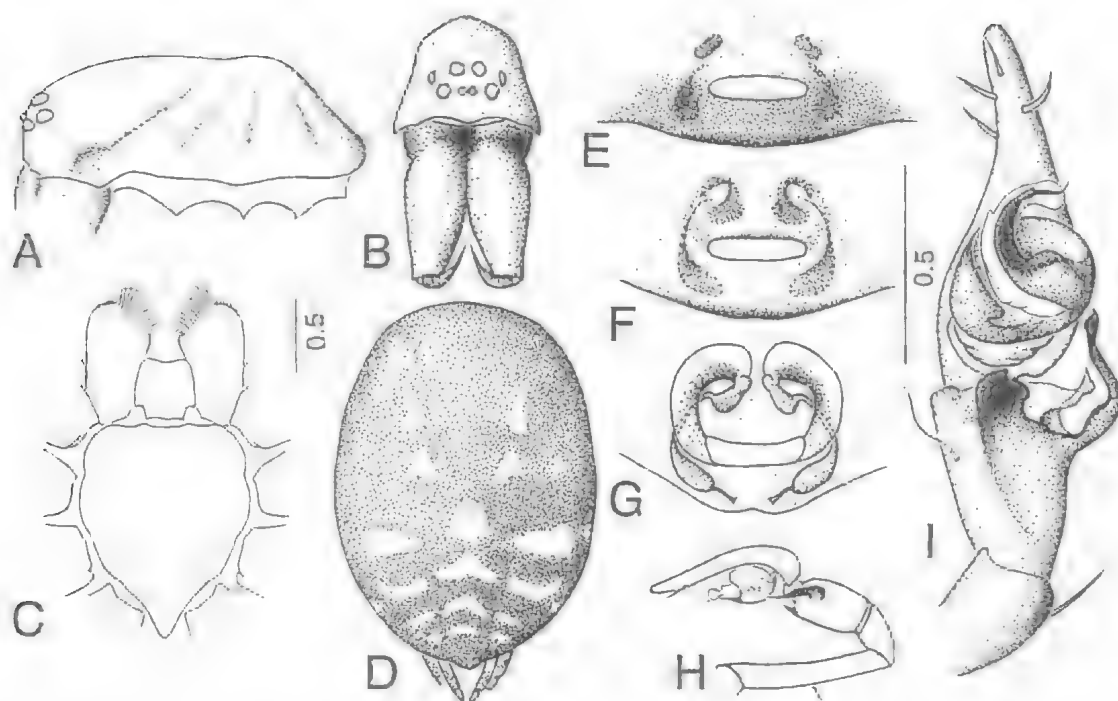


FIG. 1. A-I, *Kababina alta*. A, ♀ cephalothorax, lateral. B, ♀ eyes and chelicerae. C, cephalothorax, ventral. D, abdomen. E-G, epigynum, ventral, ventral (cleared), dorsal. H, I, ♂ palp.

to ventral portion of tibial apophysis (Fig. 1I). Paracribellar spigots present on ♀ PMS.

DESCRIPTION

Carapace straw-coloured to brown. Abdomen with pattern of pale spots (Fig. 1D). Carapace highest in foveal region (Fig. 1A). Clypeus $\times 2$ AME. Labium slightly longer than wide; endite almost twice as long as wide. Chelicera with two retromarginal and two promarginal teeth. Pro-lateral seta at base of fang longer than other setae. Legs 1423; trochanters notched. Row of tarsal trichobothria increasing in length distally; bothrium collariform (Fig. 5A); trichobothria on cymbium. Tarsal organ (Fig. 5B) slit-like broadening distally. Two cribellar fields; proximal calamistrum in ♀. Large colulus in ♂. Anterior spinnerets largest. Epigynum with wide insemination ducts running forwards, turning back at swollen glandular area, then narrowing to enter pear-shaped spermathecae. ♂ palp with branched tibial apophysis, a blunt ventral portion and two long retrolateral branches. Course of sperm duct visible postero-retrolaterally. Tracheal system simple.

REMARKS

Forster & Wilton (1973) placed most of New Zealand's amaurobioids which have a medial epigynal fossa in the Amphinectidae. *Amphinecta*, itself is characterised by having unreduced AME, 8-9 promarginal teeth on the chelicera, preening combs on metatarsi III and IV, a median apophysis on ♂ palp, and by lacking feathery hairs. None of these characters is found in *Kababina*. However *Maniho*, placed in the Amphinectidae, has reduced AME, feathery hairs and is without preening combs and also shares with *Kababina* a general similarity of structure in epigyna and ♂ palps, though *Kababina* lacks epigynal teeth and median apophysis.

Kababina is provisionally placed in the Amphinectidae.

ETYMOLOGY

Kababina - the Aboriginal word for rainforest, Kuku-Yalanji language, Bloomfield area of northeastern Queensland.

TABLE 1. Palp and leg measurements of *Kababina alta* sp. nov.

	Femur	Patella	Tibia	Metat.	Tarsus	TOTAL
♂ palp	0.8	0.4	0.6	-	0.9	2.7
I	2.3	0.8	2.2	2.5	1.4	9.2
II	2.0	0.7	1.8	1.9	1.1	7.5
III	1.8	0.7	1.6	1.8	1.1	7.0
IV	2.2	0.8	2.3	2.5	1.3	9.1
♂ palp	0.9	0.4	0.4	-	0.9	2.6
I	2.5	0.7	2.6	2.8	1.6	10.2
II	2.0	0.6	2.0	2.0	1.3	7.9
III	1.9	0.5	1.7	1.9	1.2	7.2
IV	2.5	0.6	2.4	2.8	1.4	9.7

***Kababina alta* sp. nov.**
(Figs 1, 5)

MATERIAL EXAMINED

HOLOTYPE: QMS22807 ♀, Mt Bellenden Ker Range, 17°16'S, 145°51'E, 1054m, under logs, 17.x-5.xi.1981, EWQM.

PARATYPES: QMS22808 ♂, same data as holotype, ; QMS22809 ♀; QMS22812 ♀ epigynum, QMS22810 ♀, South Peak summit Mt Bartle Frere, 1620m, 6-8.xi.1981, EWQM.

DIAGNOSIS

Epigynal fossa much wider than long. Male embolus with notch; anterior retrolateral branch

of tibial apophysis lightly sclerotised and about half length of posterior branch.

DESCRIPTION

Female: CL 2.3, CW 1.6, AL 2.4, AW 1.5. Ratio of AME:ALE:PME:PLE is 4:6:6:6. Leg measurements (Table 1). Notation of spines. Femora: I, D110, P011, R001; II, D110, P011, R011; m, D110, P001, R011; IV, D110, P001, R001. Patellae: I, D101; II, D101; m, D101; IV, D101. Tibiae: I, P011, V120; II, P011, V220, R001; m, D101, P011, V110, R011; IV, D101, P011, V111, R011. Metatarsi: several spines with whorl of 4 distally. Epigynum (Fig. 1E-G) with elliptical fossa, ratio of width: length, 1:0.2. Spinnerets (Fig. 5C-G): ALS with two major ampullate spigots, one larger than the other; about 24 piriform spigots. PMS with large anterior spigot (?cylindrical) and large posterior spigot (?minor ampullate), several paracribellar spigots and some aciniform spigots. PLS with several spigots, one larger than rest (?cylindrical).

Females varied in length, 4.1-5.0.

Male: CL 2.0, CW 1.6, AL 2.0, AW 1.2. Ratio of AME:ALE:PME:PLE is 4:6:7:6. Notation of Spines. Femora: I, D011, P011, R001; II, D111, P011, R011; m, D111, P011, R001; IV, D110, P001, R101. Patellae: I, D100; II, D101; m, D101; IV, D101. Tibiae: I, P011, V220, R011; II, D001, P011, V220, R011; m, D101, P011, V110,

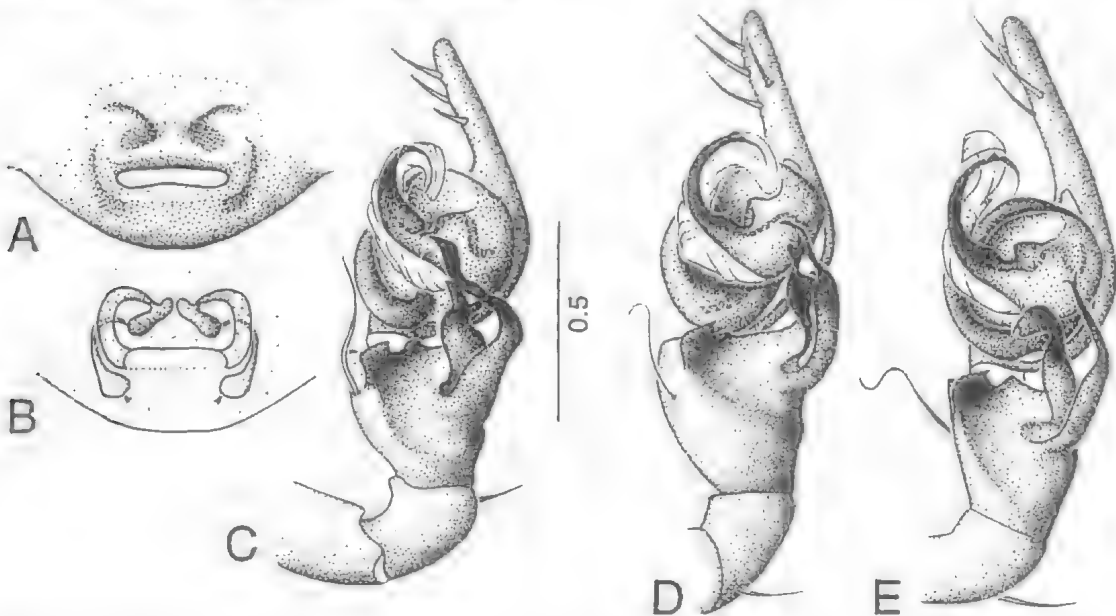


FIG. 2. A-C. *Kababina inferna*. D, *K. isleyi*. E, *K. yungaburra*. A, B, epigynum, ventral, dorsal C-E, palps

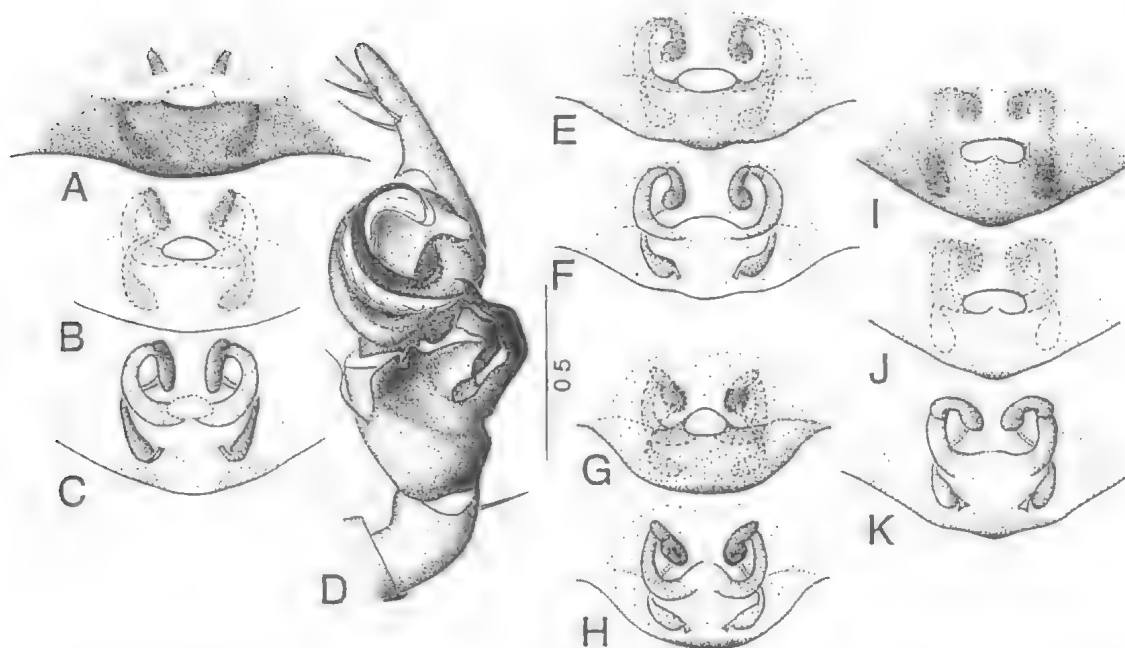


FIG. 3. A-D, *Kababina covacevichae*; E, F, *K. colemani*; G, H, *K. formurtine*; I, K, *K. superna*. A-C, I-K, epigyna, ventral, ventral (cleared), dorsal; D, ♂ palp; E, F, G, H, epigyna, ventral, dorsal.

R011; IV, D101, P111, V111, R011. Metatarsi: several spines, whorl of 4-5 distally.

Male palp (Fig. 1H, I): Long femur, broad tibia; ratio of tibial length: width is 1:0.7. Tibial apophysis with blunt ventral branch and two retrolateral branches. The anterior branch short and lightly sclerotised, the posterior long, curved and heavily sclerotised. Embolus with sub-distal notch.

ETYMOLOGY

Latin, *altus*, high, referring to the altitude.

Kababina inferna sp. nov. (Fig. 2 A-C)

MATERIAL EXAMINED

HOLOTYPE: QMS22813 ♀, Mt Bellender Ker, 500m, litter, 1-7 xi, 1981, EWQM.

PARATYPES: QMS22814 ♂, same data as holotype; QMS22815 4♀ 5♂.

DIAGNOSIS

Epigynal fossa much wider than long, ratio 1:0.15. Embolus notched; anterior retrolateral branch of tibial apophysis sclerotised, almost as long as posterior.

DESCRIPTION

Female: CL 1.9, CW 1.3, AL 2.2, AW 1.5. Colour, eye size and leg spination similar to *K. alta*. Epigynum (Fig. 2 A, B) Females varied in length, 3.5-4.2.

Male: CL 1.9, CW 1.4, AL 1.9, AW 1.2; ♂ palp (Fig. 2 C), broad tibia, ratio length: width. 1:0.9. Tibial apophysis with blunt ventral portion and 2 sclerotised retroventral branches; the anterior branch bent back before ending bluntly, the posterior longer, curving and pointed. Embolus with sub-distal notch. Large colulus; ALS with 2 major ampullate spigots, one larger than the other, 18-19 piriform spigots. PMS with a few spigots, undefined. PLS with several spigots with long thin fusules (aciniform), no large spigots seen. Males varied in length, 3.2-3.8.

ETYMOLOGY

Latin, *infernus*, lower, referring to the altitude.

Kababina isley sp. nov. (Fig. 2D)

MATERIAL EXAMINED

HOLOTYPE: QMS22824 ♂, Upper Isley Ck, 17° 03'S, 145° 41'E, 750m; 29-30.xi. 1993. DC, GBM, HJ.

PARATYPE: QMS22825 ♂, same data.

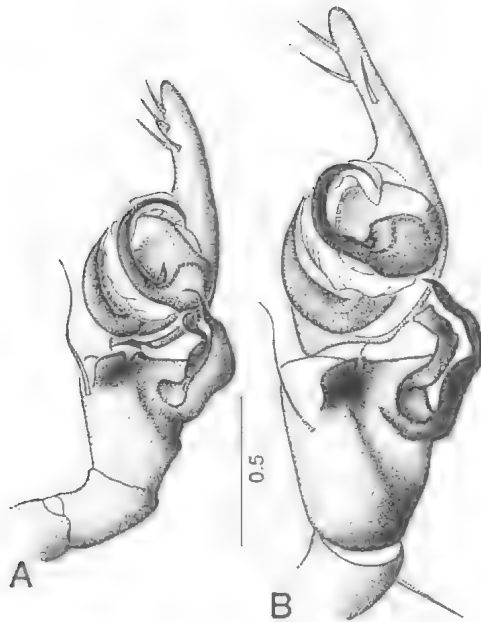


FIG. 4. A,B, *Kababina aquilonia*, ♂ palp. A, holotype; B, (Mt Spurgeon).

DIAGNOSIS

Notched embolus. Anterior retrolateral branch of tibial apophysis bifurcate.

DESCRIPTION

Male: CL 1.8, CW 1.3, AL 1.7, AW 1.0. Colour, eye size, leg spination similar to *K. alta*. Male palp (Fig. 2D), embolus notched. Tibia length: width, 1.08; anterior retrolateral branch of tibial apophysis bifurcate; posterior narrows abruptly, pointed. Paratype ♂ same size. Female unknown.

ETYMOLOGY

For Isley Creek.

***Kababina yungaburra* sp. nov.**
(Fig. 2E)

MATERIAL EXAMINED

HOLOTYPE: QMS22823 ♂, Yungaburra, 17°16'S, 145° 35'E, 700m, pitfall trap, 8-14.xii. 1988, GBM, GT.

DIAGNOSIS

Notched embolus. Anterior retrolateral branch of tibial apophysis pointed, posterior bifurcate.

DESCRIPTION

Male: CL 1.9, CW 1.5, AL 1.8, AW 1.2. Male palp (Fig. 2E). Embolus notched. Tibia length: width, 1:0.8. Tibial apophysis with blunt ventral portion, 2 sclerotised retrolateral branches, anterior pointed, posterior narrow, slightly longer, forked at tip. Female unknown.

ETYMOLOGY

For the town Yungaburra.

***Kababina covacevichae* sp. nov.**
(Fig. 3 A-D)

MATERIAL EXAMINED

HOLOTYPE: QMS22816 ♀, Shiptons Flat, 15° 48'S, 145° 45'E, under rotting log, 16-21.xi. 1975, VED, JC.
PARATYPE: QMS22817 ♂, same data.

DIAGNOSIS

Epigynal fossa wider than long, 1:0.4; glandular area of insemination duct aligned parallel to body axis. Embolus unnotched.

DESCRIPTION

Female: CL 2.0, CW 1.2, AL 2.6, AW 1.8. Coloration, eyes, leg spination similar to *K. alta*. Small epigynal fossa (Fig. 3A-C).

Male: CL 2.0, CW 1.5, AL 2.0, AW 1.3. Male palp (Fig. 3D), embolus unnotched. Broad tibia, length: width, 1:0.9. Tibial apophysis with blunt ventral portion and 2 sclerotised retrolateral branches; anterior ending bluntly, posterior curved, pointed.

ETYMOLOGY

For Jeanette Covacevich.

***Kababina superna* sp. nov.**
(Fig. 3 I-K)

MATERIAL EXAMINED

HOLOTYPE: QMS22818 ♀, Mt Lewis, 16° 34'S, 145° 16'E, 1100m, 7.xi. 1975, VED, RJR.

DIAGNOSIS

Epigynal fossa wider than long, 1:0.3; glandular area of insemination duct aligned transversely to axis of body.

DESCRIPTION

Female: CL 2.2, CW 1.5, AL 2.7, AW 1.6. Epigynal fossa width: length, 1:0.3 (Fig. 3 I-K). Male unknown.

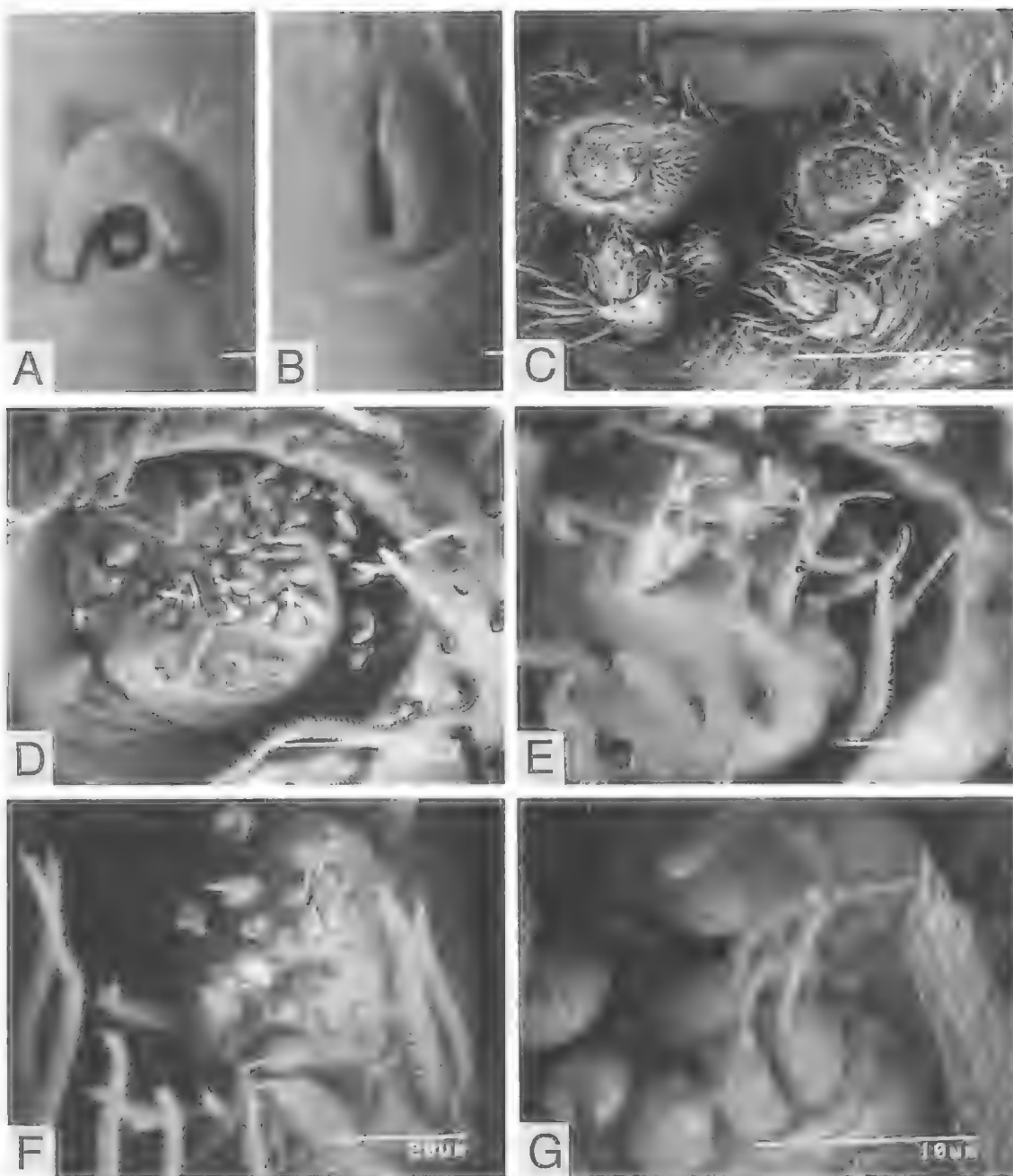


FIG. 5. A-G, ♀ *Kababina alta*. A, bothrium. B, tarsal organ. C, spinneret field. D, ALS (l). E, PLS (r). F, PMS (l). G, PMS, paracribellar spigots.

ETYMOLOGY

Latin- *supernus* - high, referring to the altitude.

***Kababina colemani* sp. nov.**
(Fig. 3 E,F)

MATERIAL EXAMINED

HOLOTYPE: QMS22821 ♀, Black Mountain, 16° 39'S, 145° 29'E, 30.i. 1972, NC.

DIAGNOSIS

Glandular area of insemination duct aligned parallel to axis of body.

DESCRIPTION

Female: CL 1.8, CW 1.4, AL 2.2, AW 1.3. Epigynal fossa width: length, 1:0.3 (Fig. 3E,F). Male unknown.

ETYMOLOGY

For the late Clyde Coleman, a north Queensland naturalist.

***Kababina formatine* sp. nov.**
(Fig. 3 G,H)

MATERIAL EXAMINED

HOLOTYPE: QMS22822 ♀, Mt Formartine South, 16° 44'S, 145° 37'E, 700m, pitfall trap, 23-24.xi. 1990, GBM, GT.

DIAGNOSIS

Epigynal fossa a little wider than long.

DESCRIPTION

Female: CL 2.1, CW 1.5, AL 2.4, AW 1.7. Epigynal fossa almost circular, width: length, 1:0.8 (Fig. 3G,H). Male unknown.

ETYMOLOGY

For Mt. Formartine.

***Kababina aquilonia* sp. nov.**
(Fig. 4A, B)

MATERIAL EXAMINED

HOLOTYPE: QMS22819 ♂, Spear Creek, nr Mt Molloy, 16° 41'S, 145° 20'E, litter, 3-10.xi. 1975, RJR, VED.

PARATYPE: QMS 22826 ♂, same data.

OTHER MATERIAL: QMS22820 ♂, Mt Spurgeon, 16° 28'S, 145° 12'E, 1100m, pitfall trap, 11-21.x.1991, GBM, HJ.

DIAGNOSIS

Unnotched embolus.

DESCRIPTION

Male: CL 2.3, CW 1.7, AL 2.3, AW 1.5. ♂ palp (Fig. 4A). Embolus unnotched. Tibial length: width, 1:0.9. Tibial apophysis with blunt ventral portion, anterior retrolateral branch lightly sclerotised ending bluntly; posterior longer, tapering to point.

Paratype ♂ smaller, 3.8. Male from Mt Spurgeon larger, (5.6) and may not be conspecific; the posterior retrolateral branch of tibial apophysis (Fig. 4B) is less tapered than the holotype.

Female unknown.

REMARKS

Males of the species can be divided into those which have a small sub-distal notch (*K. alta*, *K. inferna*, *K. isley* and *K. yungaburra*) and those without the notch, the more northerly species (*K. covacevichae*, *K. aquilonia*). Similarly females divide on the shape of the epigynal fossa; it is much wider than long in the more southern species (*K. alta*, *K. inferna*) and only a little wider than long in the remainder. The dividing line appears to be at about the latitude of Cairns (16°55'S).

ETYMOLOGY

Latin, *aquilonius*, northern.

ACKNOWLEDGEMENTS

I thank the Council of the ABRS for funding rainforest surveys during which some of this material was collected and for financial support of illustrator, Christine Lambkin. I am indebted to the Wet Tropics Management Authority for funding SEM technician, Kylie Stumkat. I acknowledge help given by "Earthwatch" and the Council for Field Research, Boston, Mass. USA for supporting the expedition to Mt Bellenden Ker. Finally thanks to the staff of the Queensland Museum, particularly Caroline Davis for her help in preparation of this paper.

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BRUSH-FOOTED TRAPDOOR (*OZICRYPTA* SP.) BURROWS AND GECKOS AT WANDO VALE, NEQ.
Memoirs of the Queensland Museum 38(2):470. 1995:—Main (1993) saw burrow openings reinforced and raised above the surface and tightly fitting, thick plug-doors primarily as adaptations against flooding. Raven (1994) discounts this as a major force in the evolution of barychelid burrow structure.

Ozicrypta sp. (Mygalomorphae: Barychelidae) were dug from their burrows and the structures photographed and drawn (Fig. 1) and rejectamenta collected. QMS30177 was from the steep, stony loam bank of a small, dry gully, 1 m from gully floor; the others (QMS30179, QMS30182) were under logs in a broad, shallow gully floor in sandy loam (Fig. 2). All were subject to short-duration flooding of unknown frequency.

Main burrows were unlined, vertical and open, openings unadorned and flush with the surface; burrow diameters were c. 15mm; depths 100–150mm. Spiders were each found in the bottom third of the burrow in a parchment-silk-lined side-chamber with the outward-opening, side-hinged door a silk-lined plug of earth. The spiders held the doors with their front legs. The burrow of QMS30179 (Fig. 1B) had three side-chambers (i, near opening, unlined, with grasshopper remains; ii, (11mm diameter, 25mm long) also near opening, silk-lined with damaged door; iii, (18mm diameter, 28mm long) silk-lined, lid intact, occupied, in bottom third of burrow). These burrows differ from the fidded and silk-lined burrows of many *Ozicrypta* which are often buried in litter (Raven, 1994) but most resemble those of *Zophorame vovacevichae*, *Tritlame* and some *Idionmata* (Raven, 1994).

A Burrow-plug gecko, *Diplodactylus conspicillatus* was found at the bottom of the burrow of QMS30177 (Fig. 1A), below the trapdoor with tail curled above its head plugging the burrow. This posture is described in Ehmann (1992). Its use of spider burrows as a daytime shelter has been reported (Pianka & Pianka, 1976; Wilson & Knowles, 1988; Greer, 1989; Ehmann, 1992). None of these authors mention the spider being present. Although Greer (1989) believed all geckos to be opportunistic arthropod feeders, Pianka & Pianka (1976) cite termites as the gecko's sole diet and record another long-bodied termite specialist, *Rhynchoelura ornata*, also sheltering in spider burrows. No gecko remains are known in the rejectamenta of *Ozicrypta* spp. An association between spider and gecko is possible though the degree of mutual benefit is unknown. *D. conspicillatus* leaves the burrow in the first three hours of the evening to forage for termites (Pianka & Pianka, 1976). The position of the side-chamber door above

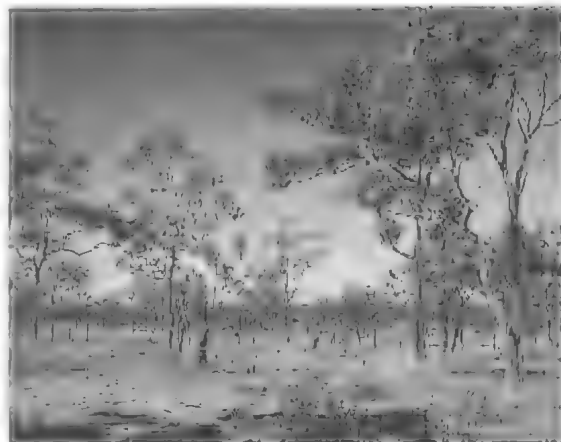


FIG. 2. Locality of QMS30179.

the bottom would allow the spider access to the surface when the gecko is in. Nightly gecko traffic might also explain the absence of outer trapdoors and silk in the main burrows. It is unknown whether *Ozicrypta* awaits prey at the mouth of its underground side-chamber (Main's "pitfall capture"), at the burrow opening or leaves the burrow entirely. As the grasshopper remains are the spiders rejectamenta, the spider must hunt at or beyond the burrow opening. Both size and behaviour of grasshoppers makes them unlikely candidates for pitfall capture.

Material Examined

Ozicrypta sp.

QMS30177 penultimate ♂, Wando Vale stn, MEQ, 19°27.22'S, 144°45.67'E, open bloodwood forest on hills, 17.IX.1995, P.Lawless, A.Cook, C.McHenry, QMS30179 immature, Wando Vale stn, 19°32.96'S, 144°40.03'E, open woodland, Narrow-leaf Ironbark, sandy loam, 11.VII.1995, P.Lawless, A.Cook, N.Camilleri. QMS30182 penultimate ♂, same data. Orthopteroid rejectamenta:—pronotum: 7.5mm long, 6.5mm high; forewings: 28mm long, 5mm high; tibia: 12mm long and femur (part).

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Philip B. Lawless, Queensland Museum, P.O.Box 3300, South Brisbane, Queensland, 4101, Australia; October, 1995.

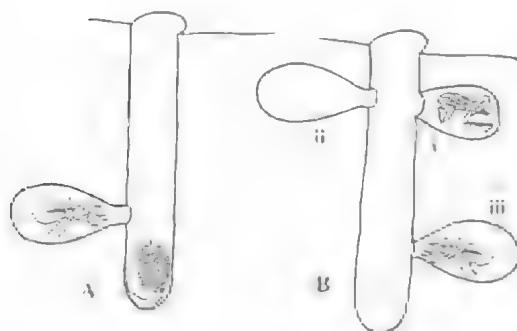


FIG. 1. Burrows of (A) QMS30177; (B) QMS30179 (i–iii, see text).

HYBRIDIZATION BETWEEN THE GREAT AND SPOTTED BOWERBIRD
CHLAMYDERA NUCHALIS AND *C. MACULATA*: AN AUTHENTICATED HYBRID
BOWERBIRD (PTILONORHYNCHIDAE).

CLIFFORD B. FRITH AND DAWN W. FRITH

Frith, C.B. & Frith, D.W. 1995 12 01: Hybridization between the Great and Spotted Bowerbird *Chlamydera nuchalis* and *C. maculata*: an authenticated hybrid bowerbird (Ptilonorhynchidae). *Memoirs of the Queensland Museum* 38(2): 471-476. Brisbane. ISSN 0079-8835.

Evidence of hybridization in the wild between the Great and Spotted Bowerbirds *Chlamydera nuchalis* and *C. maculata* (Ptilonorhynchidae) is described and illustrated from a Queensland Museum specimen. Another Queensland Museum specimen possibly represents such a hybrid and is also detailed. ☐ *Bowerbirds, hybrid.*

Clifford B. Frith & Dawn W. Frith, *Prionodura*, P.O. Box 551, Malanda, Queensland 4855, Australia; 1 August 1995.

The Australo-Papuan Ptilonorhynchidae (bowerbirds) consists of 19 species (Sibley & Monroe, 1990; Frith, 1991; Frith et al., 1995a) and was long considered closely related to birds of paradise, Paradisaeidae, (Gould, 1869; Sharpe, 1891-98; Elliot, 1873; Gilliard, 1969; Cooper & Forshaw, 1977; Schodde, 1976). Recent studies have demonstrated that the two groups are, however, phylogenetically disparate among passerines (Frith, 1994; Frith & Frith, 1990, 1994 & references therein; Sibley & Monroe, 1990; Kusiński et al., 1993; Christidis & Schodde, 1992). As they were supposedly related, and polygamous, it was anticipated that hybrids might occur between bowerbird species because such occur between polygynous taxa within Paradisaeidae (Mayr, 1941, 1962; Fuller, 1979).

Several hybrid bowerbirds have been reported, but none authenticated. A supposed hybrid between the Satin Ptilonorhynchus *violaceus* and Regent Bowerbird *Sericulus chrysocephalus* was represented by a single adult male in the iridescent blue plumage of the former species but with extensive yellow wing patches and tipping to tail feathers apparently expressing Regent Bowerbird traits. This unique specimen, known as Rawnsley's Bowerbird *Ptilonorhynchus rawnsleyi* (Diggles, 1867; Gould, 1869; Elliot, 1873; Sharpe, 1891-98; Iredale, 1950) was the subject of controversy concerning its authenticity (Chisholm, 1956) and its subsequent disappearance leaves room for doubt about its origins (Marshall, 1954; Gilliard, 1969). Hybridization must be conceded a possibility, however, between these two closely related (Frith & Frith, 1993) genera.

Two Australian monogamous bowerbirds, the Green *Ailuroedus crassirostris* and Spotted Catbird *A. melanotis*, were reported to have once hybridized in captivity (Iredale, 1950), but no specimen apparently exists to confirm the event. In the New Guinea genus *Amblyornis*, the Striped *A. subulatus* and Macgregor's Bowerbird *A. macgregoride* bred through the Owen Stanley Range. Schodde & McKean (1973) reported an Australian Museum specimen (No. 026264), lacking a locality, as suggestive of "the possibility of occasional hybridization between the two species" (Schodde & McKean, 1973). A second, more convincing, specimen of this *Amblyornis* hybrid was discovered while this contribution was with the editor (Frith & Frith, unpubl. data). The present discovery arose out of a search for an area of sympatry between breeding Great and Spotted Bowerbirds in central east Queensland based on their known distributions (Frith et al., 1995b).

METHODS

In searching for breeding sympatry between populations of the Great and Spotted Bowerbirds, we found him on Bradlee Station, c.100km SSE of Charters Towers, where each visited the bower of the other and interacted (see Frith et al., 1995b). Habitat was low open woodland dominated by acacias and eucalypts with vine thickets and an understorey dominated by Currant Bush *Carrisa lanceolata*, beneath which most bowers were located. Cryptic canvas hides were erected at bowers of both species and observations and photographs made (Frith et al., 1995b).

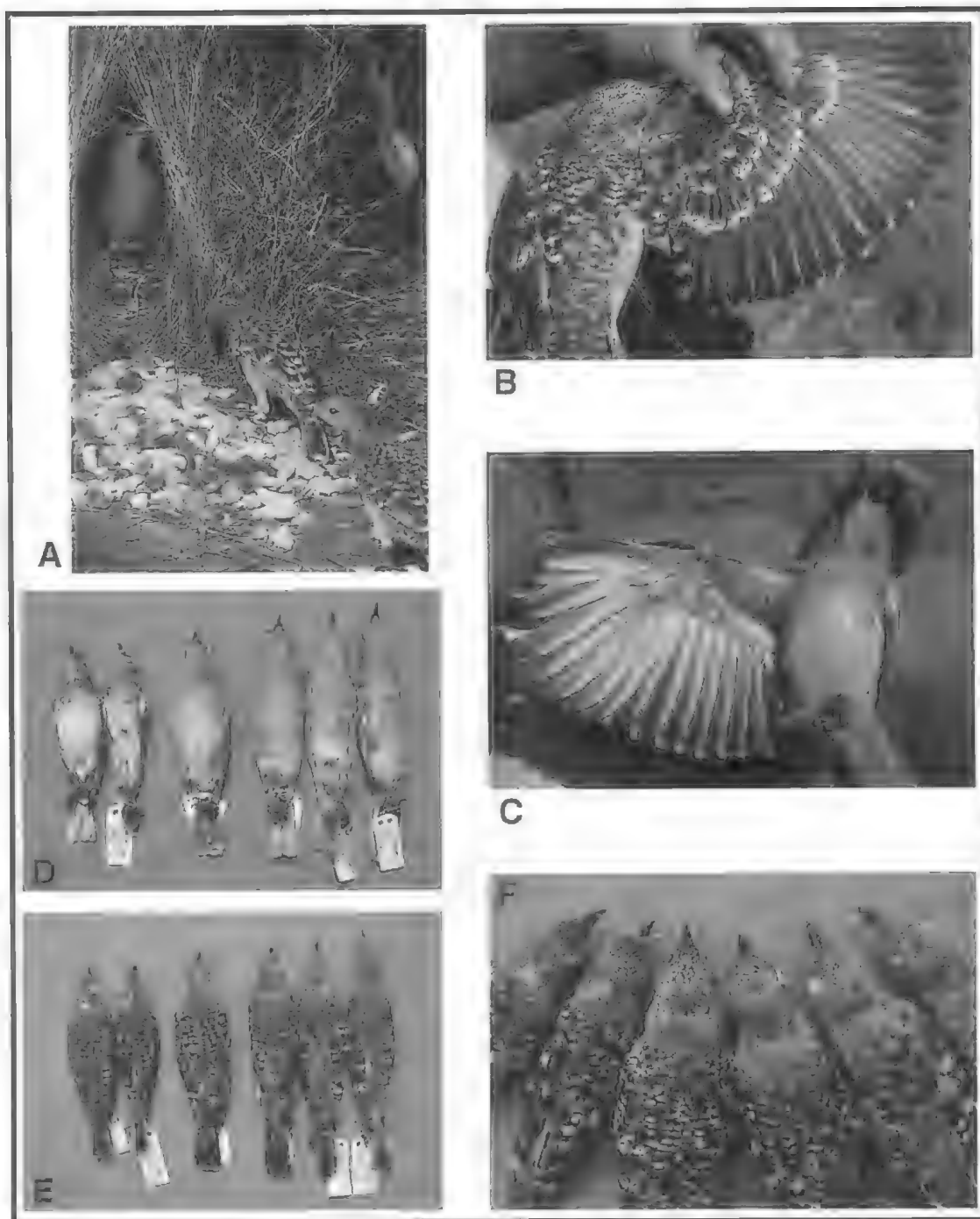


FIG. 1. A, an adult male Great Bowerbird (centre) displays his crown to the male hybrid Great x Spotted Bowerbird here described (rear) as an adult male Spotted Bowerbird (foreground) looks on. B, dorsal & C, ventral plumage detail of the live hybrid Great x Spotted Bowerbird described here, banded with ABBBS band # 081 71976 when caught on 11 September 1991. D, ventral & E, F, dorsal appearance of (l. to r.) two Spotted Bowerbird museum specimens QMO6428 & QMO27263, the hybrid Great x Spotted Bowerbird QMO30059, and three Great Bowerbirds QMO30058, QMO27527 & QMO27576.

TABLE 1. Measurements of a live hybrid Great x Spotted Bowerbird and those of live bowerbirds caught at bowers in the same area of north Queensland with the appearance of typical Great and Spotted Bowerbirds. Measurements in mm.

	Weight	Wing	Tail	Tarsus	Bill	THL
Great Bowerbird ¹						
Mean	205	172	129	47.2	38.5	67.5
Range	(187-219)	(165-175)	(121-134)	(45.1-48.7)	(37.3-39.8)	(66.1-68.4)
n =	6	6	6	6	6	3
Hybrid bowerbird ²						
	170	167	124	45.6	37.5	65.4
Spotted Bowerbird ³						
Mean	138	149	108	41.0	32.6	60.4
Range	(124-166)	(140-157)	(101-120)	(38.1-44.4)	(31.0-36.5)	(57.6-63.4)
n =	31	31	24	18	17	29

¹ Data from three birds at the Bruslee study area and three from Townsville

² Data are the average from the two examinations of the live bird (11 Sept 1991 & 1 Sept 1994) that is now specimen QMO30059.

³ Data are from 31 birds at the Bruslee study area.

Bird skin specimens examined are in the CSIRO Australian National Wildlife Collection (ANWC) and the Australian (AM), National Museum of Victoria (MV), Queensland (QM) and South Australian (SAM) museums. Capitalized descriptive words for colours are those of Smithe (1975) unless we consider them to be inappropriate, in which case we use uncapitalized words. Colour reference numbers (in parenthesis) are those of Smithe (1975) closest to that being described but not necessarily of the precise colour observed. Colours considered standard for Great Bowerbirds in the part of tropical Queensland concerned (18-23°S and 138-148°E) are taken from a subadult male (QMO30058) collected at the same location as the hybrid, and from adult specimens QMO27575 and QMO27576. Specimens of Spotted Bowerbirds used as standards for comparison with the Great and hybrid specimens are QMO6428, QMO10669, QMO10670 and QMO27263, all in richly-coloured and largely unworn plumage (Fig. 1A).

RESULTS

At one Great Bowerbird bower (bower 'A' of Frith et al., 1995b), we noted Spotted Bowerbirds also visiting, displaying and decorating. On 23 September 1989 and during late September 1990 CBF watched and photographed a bird, considered to be the same individual, that looked the size of a Great Bowerbird but which had a few dorsal feathers the rich cinnamon colour of Spotted Bowerbird plumage and heavy ventral marking and barring. This individual associated with

both the bower-owning Great and several Spotted Bowerbirds at the bower to watch and follow them as they decorated or displayed (Fig. 1A).

On 11 September 1991 a bird identified as the same individual was mist netted at the same Great Bowerbird bower, photographed (Fig. 1B,C) and measured (Tables 1 & 2). At that time we thought it to be hybrid but as

the possibility it was an abnormally plumaged immature Great Bowerbird remained, we banded and released it (ABBBS band 081 71976). Its pink crest was then one third developed, its mouth yellow and its gape pink-yellow. On 1 September 1994 this individual was again caught at the same bower. At this time the bird, now known to be at least four years old, was fully crested with a flesh-yellow mouth and plumage characters of both Great and Spotted Bowerbirds. As we now had no doubt the bird was hybrid, we collected and prepared it as a skin for the Queensland Museum (QMO30059). It had a fully ossified skull and enlarged (10 x 7mm) gonads.

DESCRIPTION OF THE GREAT X SPOTTED HYBRID BOWERBIRD SPECIMEN QMO30059

The hybrid differs ventrally from adult-plumaged Great Bowerbirds in not having the throat, breast and flanks uniform buff-grey (Light Drab 119C) but a darker colour, closer to Grayish Horn (91), because of the influence of heavy mottling and spotting that develops into barring on the sides of the chest and continues down the flanks and onto the thighs. A few of the most heavily barred feathers to either side of the chest are washed with pale Cinnamon (39) which is stronger on the concealed, basal, part of them. The central abdomen and belly is cream-yellow (54) as in Greats but it extends further up toward the chest as in Spotted Bowerbirds. Undertail coverts and undertail are as in typical Greats but these differ little from those of Spotted Bowerbirds.

TABLE 2. Measurements of Great and Spotted Bowerbird skin specimens from north Queensland localities most near the Bruslee study area in Australian collections and those of a hybrid individual from these parent species. Measurements in mm.

	Weight	Wing	Tail	Tarsus	Bill	THL
Great Bowerbird ¹						
Mean	212	170	132	45.3	37.6	65.3
Range	(175-317)	(162-180)	(125-141)	(42.2-49.4)	(35.2-41.7)	(63.3-70.6)
n =	12	12	12	12	12	5
QMO27590	276	168	125	45.3	38.5	
Hybrid bowerbird ²	170	167	124	45.6	37.5	65.4
Spotted Bowerbird ³						
Mean	140	149	112	40.3	32.7	59.6
Range	(117-158)	(144-154)	(101-117)	(36.9-43.1)	(29.9-35.4)	(57.7-61.6)
n =	8	12	12	12	12	9

¹ Specimens are from: 25 km S of Townsville (CSIRO 41509♂, 41510♀, 41513♂), Gilbert River, 74km W of Georgetown (CSIRO 37492♀, 41626♀, 41627♀), near Esmeralda Homestead (QMO27575♂, 27576♂, 27590♂ [possible hybrid - see text]), 18km S of Clermont (CSIRO 43179♂), 31km N of Lynd Junction (CSIRO 43141♀) and 19km NE of Inverleigh Homestead (QMO27515♂).

² Data are averaged from the 11 Sept 1991 and 1 Sept 1994 examinations of the live bird that is now specimen QMO30059.

³ Specimens are from: c. 100km NW of Clermont (QMO10669♂, 10670♀), 67km N of Hughenden (CSIRO 43157♂, 43158♀), Waverley Creek crossing, Boulia-Mt. Isa Highway (QMO27263♂), Wernading Homestead (QMO27373♀), near Mt. Isa (CSIRO 6621♀, 41756♀, 41757♀, SAMB 20505♀), Collulam Homestead (QMO27303♂) and SW Barcaldine (CSIRO 37321♂).

Unlike adult, subadult and immature Great Bowerbird plumages the hybrid's malar, lore and ear coverts are distinctly mottled with the same Grayish Horn (91) as the throat and breast. Unlike Greats but as typical of Spotted Bowerbirds there is an indistinct but clearly visible pale off-whitish malar stripe (only just apparent in Fig. 1C).

The hybrid is dorsally different from typical Greats of any age. The wings are generally similar to those of an adult Great except that the extensive pale tips to primary covert feathers are not off-white or whitish but are washed with pale Cinnamon (123A) as in, but paler than, Spotted Bowerbirds. The crown feathering is intermediate between that of the two species. The feathers are not simply tipped with pale Buff (124), or whitish as in Greats, or streaked with rich Raw Sienna (136) conspicuously edged with dark grey-brown (119A) as in Spotted, but are centrally spotted Pale Horn (92) washed to varying intensity, but stronger nearer their bases, with pale (39) to darker (123A) Cinnamon (Fig. 1D-F). Crest colour in the hybrid is Rose pink (9) but may be Magenta (2) or be shot with Purple (1) in some light as is true of both putative parent species. Some forwardmost and hindmost crest feathers are tipped silvery-white. Posterior to the

crest is a discrete area of contrastingly uniform brownish Glaucous (79).

Mantle, back and rump feathers show characters of both putative parents but are more like those of Spotted in being more blackish, almost black on the central back, unlike the dark grey-brown (221) of Great Bowerbird back feathers. These feathers on the hybrid do have the broad pale-grey tipping that gives the scalloped appearance of the Great's dorsal plumage but this is rendered inconspicuous by large central feather spotting

of the Spotted Bowerbird type of marking. These spots, not as large or symmetrical as in the Spotted but nothing like Great plumage, vary in colour from a pale almost creamy off-white (92) to, in few places, the Cinnamon (123A) and rich Mikado Brown (121C) typical of Spotted Bowerbirds (Fig. 1D-F). Table 3 comparatively summarizes characters.

Primary feather colouring and marking is more like that of the Great than the more brownish and extensively paler-marked Spotted Bowerbird. Rump feathers have a conspicuous dark sub-terminal band typical of Spotted but not of Great Bowerbirds. Upper tail colour and markings are not discernable from those of Great Bowerbirds. Adult Greats have a clear yellow mouth and Spotted a fleshy one, the mouth of the hybrid being intermediate between them. Measurements of the hybrid specimen are compared with those of live (Table 1) and skin Great and Spotted Bowerbirds (Table 2).

Mitochondrial DNA study of material from the trunk of the hybrid specimen confirms that the female parent was a Great Bowerbird and the father, therefore, a Spotted Bowerbird

TABLE 3. Some characters of adult Great and Spotted Bowerbirds in central east Queensland compared with those of a hybrid between the two of them

Character	Great	Hybrid	Spotted
Throat, breast & flanks	Uniform light drab (119C)	Greyish horn (91)	Cream-yellow (54) streaked blackish
Abdomen, belly & chest	Cream-yellow (54) but chest light drab (119C)	Cream-yellow (54)	Cream-yellow (54)
Pale malar stripe	Absent	Present	Present
Lore & ear coverts	Uniform light drab (119C)	Mottled Greyish horn (91)	Mottled pale cinnamon (123A)
Pale primary covert tips	Off-white	Very pale cinnamon (123A)	Cinnamon (123A)
Crown feathering	Tipped pale buff (124) to whitish	Centrally spotted pale horn (92) washed pale (39) to darker (123A) cinnamon	Streaked raw sienna (136) & edged dark grey-brown (119A)
Subterminal dark band on rump feathers	Absent	Present	Present
Central back feathering	Dark grey-brown (221)	Blackish	Black
with broad pale scalloping	Present	Present	Absent
and large central feather spotting	Absent	Present	Present
Mouth colour	Yellow	Yellowish-pink	Flesh-pink

(Christidis, pers. comm.; Christidis, Frith & Firth, unpubl. data).

DISCUSSION

Characters in the hybrid peculiar to the Spotted Bowerbird are the pale malar stripe, heavily mottled and barred breast and flanks, sienna-streaked crown and spotted back feathers. Notwithstanding these unequivocal traits, the hybrid is far larger in all measurements than any Spotted, being the size of a small Great Bowerbird (Table 1). Peculiar to the Great is dorsal spotting paler than the rich cinnamon typical of Spotteds. The hybrid is markedly smaller than most male Great Bowerbirds, particularly in weight, (Tables 1 & 2). Its weight on 11 September was 168g and on 1 September 1994 172g. Thus its average weight of 170g is lighter than that of all six Greats trapped at its specific location (Table 1) and that of 12 taken (immediately after collected) over that area of north Queensland (Table 2). Its wing is smaller than most Great Bowerbirds and its tail more so (Tables 1 & 2). From its plumage at the time we are reasonably confident the hybrid bird was at least two, probably three, years old when banded on 11 September 1991. Thus it was at least five years old when collected. These facts and observations leading to the collection of specimen QMO30059 clearly indicate it is the product of hybridization between Great and Spotted Bowerbirds.

Mention should be made of a bird (QMO27590) collected by Julian Ford 10km N of Esmeralda Homestead, north Queensland on 18 September 1986 with unenlarged gonads but a fully ossified 'adult' skull and identified as *C. nuchalis* because it may be hybrid. This tentative suggestion is made because the characters now obvious in the Bruslee hybrid (Fig. 1A) were far less so three years prior to its collection (Fig. 1A-C). At that time its back feathers appeared less black, its whitish primary coverts lacked the cinnamon wash, and its crest was only one third developed.

While QMO27590 has the dorsal plumage of a Great, it has several lower back and upper rump feathers washed with pale Cinnamon (123A) with a dark subterminal band as found in Spotted Bowerbirds. It shows no sign of the pale malar stripe or heavy darker mottling on ear coverts and side of neck typical of Spotted Bowerbirds and present in the Bruslee hybrid, but it is heavily mottled and barred on the throat, chest and flanks much like the hybrid. Notwithstanding an ossified skull, the lack of gonad activity at peak courting season and only one pink nuchal crest feather indicates it to be a subadult. Weight and measurements of Ford's specimen (Table 2) provide inconclusive evidence of hybridization, however, and it is therefore treated here as a subadult *C. nuchalis*. Should both bowerbird species prove to occur where it was collected a hybrid origin becomes, however, a stronger possibility. Hybrids may not always be as obvious as

the specimen recorded here, and may more resemble one or other of the putative parents. Given the potential extent of sympatry of bower-maintaining Spotted and Great Bowerbirds in central northeastern Queensland (Frith et al., 1995b) it is possible that occasional hybridization between the two is more widespread.

ACKNOWLEDGEMENTS

This study would have been impossible without the kind support, interest, friendship and hospitality of the McCullough family whom we thank sincerely. We thank Philippa Horton, SAM; Richard Schodde, Ian Mason and John Wombey CSIRO, ANWC; Walter Boles, AM and Stephen Van Dyck, Glen Ingram and Wayne Longmore, QM for access to specimens in their care and other help. Mary McCroy provided Smith (1975) for this study. Walter Boles, Les Christidis, Richard Schodde and an anonymous referee provided constructive comment on a draft manuscript. Les Christidis provided evidence of the maternal parentage of the hybrid. Dedicated to the memory of Julian R. Ford who contributed greatly to the understanding of distributions and radiations of Australian birds including both putative parents of the hybrid described herein.

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A REVISION OF *DIACARNUS* BURTON AND *NEGOMBATA* DE LAUBENFELS
(DEMOSPONGIAE: LATRUNCULIIDAE) WITH DESCRIPTIONS OF NEW SPECIES
FROM THE WEST CENTRAL PACIFIC AND THE RED SEA

MICHELLE KELLY-BORGES AND JEAN VACELET

Kelly-Borges, M. & Vacelet, J. 1995 12 01: A revision of *Diacarnus* Burton and *Negombata* de Laubenfels (Demospongiae: Latrunculiidae) with descriptions of new species from the west central Pacific and the Red Sea. *Memoirs of the Queensland Museum* 38(2):477-503. Brisbane. ISSN 0079-8835.

Species previously assigned to the genus *Latrunculia*, which possess discate microthabds as the microscle complement, have been re-evaluated and assigned to *Diacarnus* Burton and *Negombata* de Laubenfels, which both contain spinulate rather than discate microthabds microscle. The type species of *Diacarnus*, *Axos spinipoculum* Carter, is redescribed, and seven new species are described: *D. bellae*, *D. erythraeanus*, *D. levii*, *D. ardoukoba*, *D. bismarckensis*, *D. tubifera*, and *D. megaspinorhabdosa*, spp. nov. The type species of *Negombata*, *Latrunculia corticata* (Carter), is redescribed and the only other known species, *Latrunculia magnifica* Keller, is transferred to *Negombata*. Diagnostic morphological characters which emphasize a combination of gross morphology, spicule dimensions, microscle morphology and disposition, are identified for *Diacarnus* and *Negombata* and the affinities of these and other latrunculiids, *Latrunculia* and *Sigmosceptrella*, are compared to each other and to other demosponges. New locality and species records reveal a remarkably disjunct biogeographic distribution for *Diacarnus*: the greatest diversity of species is found in northern Papua New Guinea and in several Micronesian atolls, but the genus extends east through New Caledonia to Fiji, and south to Port Jackson in south-eastern Australia. Two species of *Diacarnus* are also found in the Red Sea. The genus has not been recorded in the published literature, nor in the extensive unpublished collections known for the Indo-Malay region. □ *Demospongiae*, *Latrunculiidae*, *Micronesia*, *Red Sea*.

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Sponges having discorhabds, dicasters or spinulate acanthomicrothabds as microscle have traditionally been placed within *Latrunculia* Bocage, Latrunculiidae Topsent. Distinctive microscle of *Latrunculia* bear four whorls of spines frequently united in a disc, on a straight axial rod, which are disposed in an erect layer above the sponge ectosome. *Latrunculia* contains massive sponges with papillae and sieve-pore areas, with skeletons of monactinal or rarely diactinal spicules arranged in an irregular reticulation of poorly defined, somewhat plumose, tracts. Other latrunculiids such as *Podospongia* Bocage, *Sigmosceptrella* Dendy, and *Barbozia* Dendy, contain acanthomicrothabds. The affinities of these genera have been diversely interpreted, resulting in allocation of the family either in the tetractinomorph Hadromerida, following Bergquist (1978), or in the ceractinomorph Poecilosclerida following Topsent (1922).

However, it is unlikely that acanthomicrothabds, which are a distinctive feature of the family as presently recognised, are homologous in all of these genera. The genus *Latrunculia*, which contains discorhabds, has received several species which are certainly atypical. Two species from the Red Sea, *Latrunculia corticata* Carter, 1879 (with its claimed junior synonym *L. magnifica* Keller, 1889), and *L. purpurea* Carter, 1881, were isolated in a new genus *Negombata* by de Laubenfels (1936), a distinction which had been suggested long ago by Ridley and Dendy (1887) and Thiele (1900). De Laubenfels differentiated these specimens from *Latrunculia* on the morphology of the microscle which are spinulate sanidaster-like acanthomicrothabds, rather than discate as in *Latrunculia*. The position of *Axos spinipoculum* (Carter, 1879), transferred to *Latrunculia* by Hooper (1986), is doubtful. Burton (1934) proposed the new genus *Diacarnus* to receive *Axos spinipoculum* Carter in recognition of the charac-

teristic acanthomicrohabds which consisted of a straight shaft bearing four whorls of spines.

We have found several sponges in the West Central Pacific and in the Red Sea which are characterised by the possession of spinulate rhabds, hereafter termed spinorhabds. These microscleres are thin rods with spines or bumps scattered irregularly or uniformly in 4 whorls along the shaft. The microscleres of these new sponges are clearly related to those of *Axos spinipoculum* Carter, *Latrunculia* (= *Negombata*) *corticata* Carter, and *L.* (= *Negombata*) *magnifica* Keller. These species are re-evaluated in the light of this new material.

METHODS

Sponges were collected using SCUBA by the authors and the Coral Reef Research Foundation (CRRF), Micronesia, from Chuuk (Truk) State, Micronesia, the Australian Great Barrier Reef, northern and southern Papua New Guinea, New Caledonia, Fiji, the Philippines, the Red Sea, and the Gulf of Aden (Fig. 4). On collection, samples were preserved in 70% ethanol or in 10% formalin and prepared for histological examination as described in Kelly-Borges et al. (1994). The dried holotype of *Latrunculia* (= *Negombata*) *corticata* (Carter) was reconstituted by prolonged soaking of a fragment in dilute detergent. The colour notation for living and preserved specimens follows the Rheinhold Colour Atlas (Kornerup & Wanscher, 1961). Spicule dimensions are given as mean length (range of length measurements) times width (range of width measurements) followed by the number of spicule measurements taken. Primary type material has been deposited in the Queensland Museum, Brisbane, Australia, paratypes and fragment of holotypes, schizotypes of some authors, have been deposited in the Natural History Museum, London, and in the Muséum National d'Histoire Naturelle (Paris). Registration numbers are cited in the text.

Abbreviations used in the text: QM, Queensland Museum, Brisbane; BMNH, Natural History Museum, London; MNHN, Muséum National d'Histoire Naturelle, Paris; HBOM, Harbor Branch Oceanographic Museum, Fort Pierce, Florida; SIO, Scripps Institute of Oceanography, San Diego; NSRC (UPNG), Natural Science Resource Centre, University of Papua New Guinea, Port Moresby; CRRF, Coral Reef Research Foundation, Federated States of Micronesia; OCDN, Specimen sample numbers for United States National Cancer Institute shallow-water

collection program contracted to the CRRF. A complete collection of all OCDN specimens is located at the Smithsonian Institution (United States National Museum); Q66C, Specimen sample numbers for United States National Cancer Institute shallow-water collection program previously contracted to the Australian Institute of Marine Science, Townsville. This latter collection is now located at the Queensland Museum.

SYSTEMATICS

Family LATRUNCULIIDAE Topsent

Diacarnus Burton, 1934

Diacarnus Burton, 1934: 549

TYPE SPECIES

Axos spinipoculum Carter, 1879: 286

DIAGNOSIS (emended)

Massive spherical or barrel-shaped, lobate-digitate, repent-branching, tubular or thickly encrusting Latrunculiidae. Surface with single or multiple conules or blunt broad tubercles or mounds, microscopically smooth, slippery and rubbery. Ostia radiate in stellate formation in shallow rounded depressions, oscules apical with low fleshy raised collars, frequently differentially coloured cream, always highly contracted and invisible in preserved specimens. Texture extremely tough but elastic. Colour usually pale purple-pink mottled with deep reddish brown and yellow brown, interior cream. Megascleres subtylostongyles, with a faint subterminal swelling at proximal end, distal end oxeote or more typically strongylote. Microscleres, two size categories of spinulate acanthomicrohabds (spinorhabds), smallest category always present and disposed on and below scalloped ectosome-choanosome boundary, second larger category, disposed within the ectosome and choanosome when present. Skeletal arrangement plumoreticulate. Primary fibres, conspicuous, appearing as vertebrate ligaments in soft flesh. Megascleres are packed and arranged parallel within axis of fibre, spongin barely visible, fibre is often hollow. Multiple fine dendritic spicule tracts emanate from tip of primary fibre as it passes into ectosome in an umbelliform arrangement, fibres radiating towards surface terminating in ectosomal megasclere brushes. Primary fibres, connected by occasional short secondary fibres, or anastomosing with adjacent fibres.

Ectosome, dense, rubbery, distinct from the underlying choanosome, with layers of collencytes and collagen fibrils parallel to surface. Choanosome, dense, with a few large canals surrounded by a dense layer of contractile cells and collagen fibrils. Fibres are surrounded by a sheet of elongate cells and bundles of collagen fibrils. Sponges incubate huge, bright orange-yellow parenchymella larvae.

***Diacarnus spinipoculum* (Carter) comb. nov.**
(Figs 1, 4A, 5A, 6A, 7A, 8A; Table 1)

Axos spinipoculum Carter, 1879: 286

Diacarnus spinipoculum; Burton, 1934: 549

Latrunculia spinipoculum; Hooper, 1986: 181

MATERIAL EXAMINED

HOLOTYPE: BMNH 1846.10.14.174 from Port Jackson, Sydney, growing on "hard objects" (Carter 1879), depth unknown, presented by J. B. Jukes, Esq (Fig. 1).
ADDITIONAL MATERIAL: BMNH 1994.5.22.3, west side of East Fayu Island, Chuuk State, 8°32.61'N, 151°20.01'E, on ledge on outer wall, 24.4 m, collected by P. L. Colin, CRRF, 14 January 1994; BMNH 1994.5.22.4: East Fayu Island, Chuuk State, 8°32.61'N, 151°20.01'E, oceanside, on vertical wall, 10m, collected by P. L. Colin, CRRF, 14 January 1994; BMNH 1994.8.20.1, (fragment of OCDN 2559-Q): Blast Pass, 27m, Fiji Islands, collected by C. Arneson, CRRF, 20 August 1994; *Negombo tenuistellata* Dendy - BMNH 1907.2.1.28.

DESCRIPTION

Large spherical or oval barrel-shaped, (Fig. 5A), up to 50cm high, 40cm diameter, with a deep apical central atrium, 4-5cm diameter. Several sponges can be joined basally. Oscules, scattered on interior walls of atrium. Surface, heavily tuberculate to mammillate (conulose in the preserved holotype due to shrinkage), rubbery and microscopically smooth to touch, compressible, elastic in life, barely compressible in alcohol. Colour in life, mahogany brown (8E7), mottled with pale pinkish red (8C7), rim of apical atrium and atrium walls cream-white. Cream in ethanol.

Skeleton. Large primary fibres, 500-900µm diameter, radiate towards sponge surface, connected by rare short secondary fibres, 250-300µm diameter, or anastomosing with adjacent primary fibres in deeper choanosome (Fig. 6A). Primary fibre tip divides into an umbel of numerous slender dendritic spicule tracts, 38-70µm diameter, where the primary fibre passes through ectosome-choanosome boundary. Dendritic spicule tracts occasionally branch below surface and diverge and ramify within ectosome, where they

form slightly fanned brushes after narrowing to 5-10µm or only 1-4 spicule widths. Megascleres form a palisade of brushes between dendritic tract brushes. Megascleres, scattered singly or in groups of 1-3 spicules, in a vaguely radiate to confused arrangement interstitially between primary fibres. Larger thicker microscleres are scattered predominantly around edges of exhalant canals in choanosome, around ectosomal lacunae, and just below lower boundary of ectosome where smaller thinner spinorhabds are also found. Ectosome, 1200-1500µm deep, extremely dense with parallel collagen fibrils, easily distinguished from underlying choanosome which is dense and soft.

Spicules. *Megascleres.* Subtylostrostrongyles with slight subterminal swelling: 266(232-305) x 4(2-7)µm (see Table 1).

Microscleres. Spinorhabds I: extremely fine with small sharp spines scattered along shaft; 46(37-55) x <1µm, n=10 (Fig. 7A). Spinorhabds II: with four groups of spines, terminal spines frequently strongly recurved, central spines irregular in shape and length; 57(53-65) x 2(1-5)µm, n=20 (Table 1, Fig. 8A).

SUBSTRATE, DEPTH RANGE, ECOLOGY

Solitary, on oceanside reef slopes, from 10 to 27m depth.

GEOGRAPHIC DISTRIBUTION

Port Jackson, Sydney; East Fayu Island, Chuuk State, Micronesia; Fiji Islands (Fig. 4A).

REMARKS

The holotype was described by Carter (1879), and more recently by Hooper (1986), as an "elongate, subcylindrical, solid, cup-shaped with an apical depression" (Fig. 1). Examination of new material from Micronesia, and Fiji, reveals that the species has a large, deep, central atrium in life, with oscules opening into the atrium. The holotype would have almost certainly been spherical or barrel-shaped in life, with a restricted base of attachment as in the fresh material, but the specimen is now compressed laterally within the confines of the container. The surface of the preserved sponge is tuberculate but in life the tubercules are more distinctly mammillate.

Carter (1879) emphasised the characteristic "chondroid" nature of the thick ectosome and the extremely thick, tough fibres set in a relatively soft, compressible choanosome (Fig. 6A). This later feature was not emphasised in Hooper's description, based as it was on an inadequate

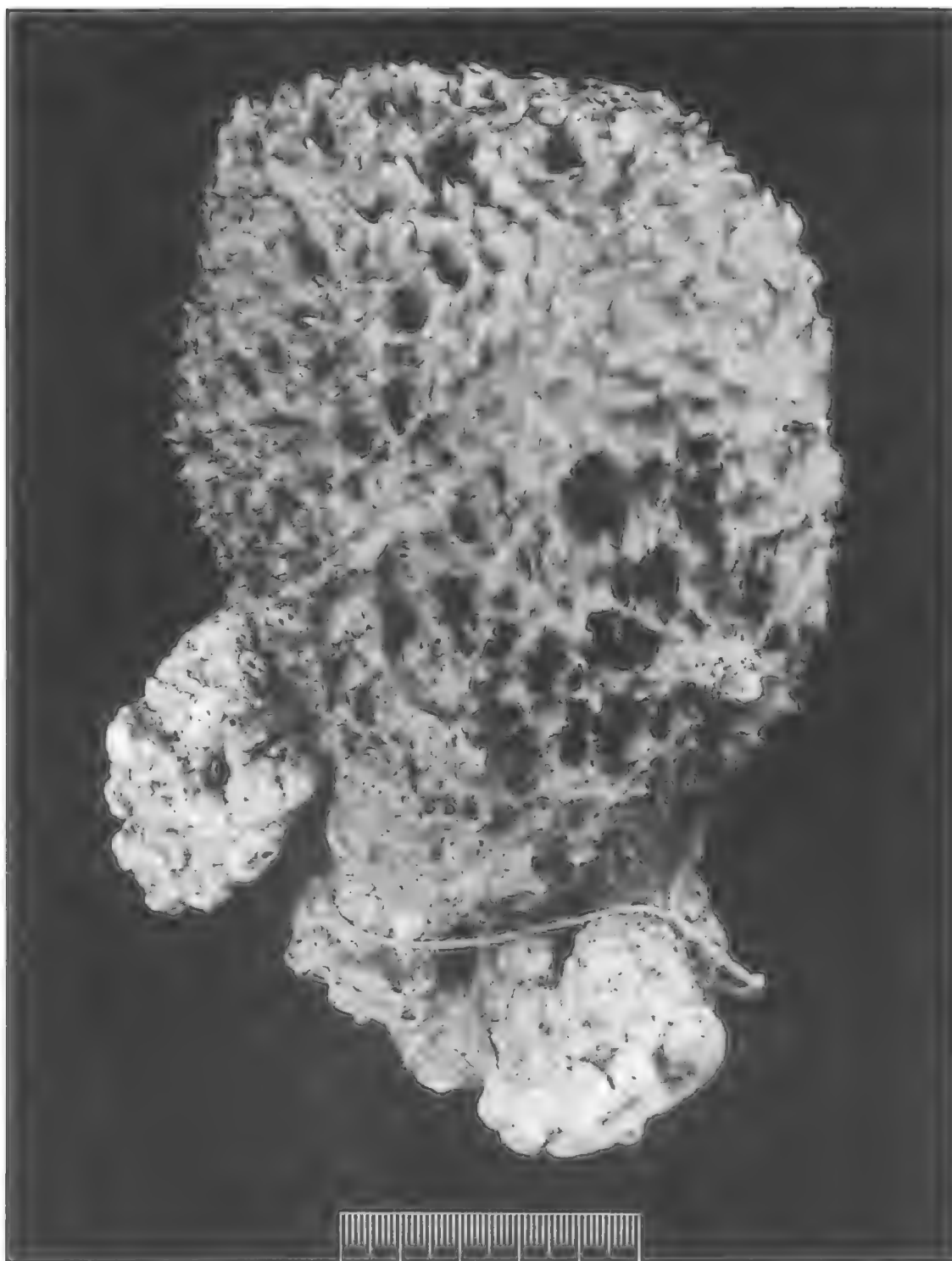


FIG. 1. *Diacarnus spinipoculum* (Carter), preserved holotype BMNH 1846.10.14.174, Port Jackson, Sydney. Scale: 5cm.

TABLE 1. Spicule dimensions of *Diacarnus spinipoculum* (Carter) and *Diacarnus bellae* sp. nov., given as mean length(range), mean thickness (range), all in μm .

	Megascleres	Spinorhads I	Spinorhads II
<i>Diacarnus spinipoculum</i> (Carter) Holotype BMNH 1846.10.14.174	277(232-305) (6.4-7)	53(50-55) <1	60(53-65) (5.2-5)
BMNH 1994.5.22.3	255(240-269) (3.5-5)	42(38-48) <1	55(53-60) (1-2)
BMNH 1994.5.22.4	266(250-278) (2-5)	43(37-46) <1	55(53-60) (1.5-2.5)
<i>Diacarnus bellae</i> sp. nov. Holotype fragment BMNH 1994.5.22.7	269(250-280) (2.5-5)	42(36-45) <1	46(43-50) (2-3)
BMNH 1994.5.22.9	280(250-300) (2.5-3)	45(40-50) <1	45(40-48) (1-2.5)
BMNH 1994.5.22.11	270(250-290) (2.5-5)	absent	44(40-48) (1-2)

older histological section of the holotype, and so the most diagnostic field characteristic of the sponge had not been reported in recent literature. The unusual and characteristic skeletal arrangement of the umbelliform primary fibres within the ectosome, observable only with detailed serial histological sectioning, was also not possible to detect in the slide of the holotype, nor were the two size categories of microscleres. The ectosomal megasclere brushes are paratangential in orientation in the holotype slide (Hooper, 1986) but are vertical, as in the living sponge, where the ectosome has not been squashed due to confinement in its container.

Two specimens from East Fayu Island have been assigned to *Diacarnus spinipoculum* (Carter) even though the spicule dimensions are slightly different from the holotype; there is considerable variation between all specimens examined and spicule dimensions cannot be considered alone in differentiation of species in *Diacarnus*. Even though the spicule dimensions of these specimens are slightly more similar to the later described *D. bellae*, spicule morphology is very different and identical to that of *D. spinipoculum*.

In a revision of *Axos* Gray from north-western Australia, Hooper (1986) transferred *Axos spinipoculum* to *Latrunculia*, considering the general skeletal features of *A. spinipoculum* to be similar to those of *Latrunculia* s.s. The type species of *Latrunculia*, *L. cratera* Bocage 1869, has several characteristic features described clearly by Bocage (1869), and later recognised by Ridley and Dendy (1887) in the descriptions of *Latrunculia apicalis* and *L. brevis* (Ridley & Dendy, 1886). Diagnostic features include the

possession of dicastra, which form a single ectosomal layer of erect spicules, their bases implanted in the dermal membrane (Fig. 9D). The dicastra or discorhabds of *Latrunculia* s.s. have two central whorls of serrated discs that are usually of unequal diameter and which are invariably located closer to either end of the spicule. The ectosomal arrangement of the dicasters is well illustrated by Bocage (1869; pl. 11, fig. 2b) and the variety of dicasters in *Latrunculia* obvious in the illustrations of Ridley and Dendy (1887) and Bergquist (1968: 18, fig. 2). The megasclere skeleton is typically a wispy loose irregular reticulation of indistinct tracts, megascleres

are styles, and microscleres are discorhabds. The surface of *Latrunculia* has characteristic mammiform ostial sieve-plates. The transfer of *Axos spinipoculum* to *Latrunculia* by Hooper (1986) is therefore invalid, as it differs considerably in the form and disposition of the microscleres, the form and disposition of the fibre skeleton, mesohyl matrix construction and in surface morphology.

Hooper (1986) also suggested *Axos spinipoculum* and *Negombo tenuistellata* Dendy 1905 from Ceylon are synonymous but conceded that the microscleres of the former are more regular than those of *Negombo*. Examination of *N. tenuistellata* (BMNH 1907.2.1.28) and histological sections of this sponge, reveal that it is very different in morphology and spiculation from *A. spinipoculum*: *N. tenuistellata* is a series of compressible thin-walled coalescent tubes, the skeleton of which consists of large gently curved styles in confused longitudinal tracts, reminiscent of the halichondroid organisation, with minute microspined sanidaster-like microscleres scattered interstitially and in a dermal membrane (Fig. 8H). The microscleres of *N. tenuistellata* are acanthose microrhabds with irregular whorls of spines along the shaft, and are much smaller than the microscleres of the *Latrunculiidae*. *Axos spinipoculum* and *N. tenuistellata* are not synonymous and neither have microscleres typical of *Latrunculia* s.s. *Negombo* was incorrectly placed in the *Spirastrellidae* by Dendy (1905), there is no evidence of spiralling along the shaft of the spicule. De Laubenfels (1936: 132) used the name *Negombo* for an alleged desmoxiid sponge. This genus name has not been used since, to our knowledge.



FIG. 2. *Negombata corticata* (Carter), dry holotype BMNH 1840.5.6.56-58, three dried fragments of the same specimen, Red Sea. Scale: 5cm.

***Diacarnus bellae* sp. nov.**
(Figs 4B, 5B, 5C, 6B, 7B, 8B; Table 1)

MATERIAL EXAMINED

HOLOTYPE: QMG305007: Anaw Wall, oceanside of reef west of Anaw Channel, northwest side of Chuuk Atoll, Micronesia, 7°34.24'N; 151°40.19'E, 24m, collected by P. L. Colin, CRRF, 7 August 1993; **FRAGMENT OF HOLOTYPE:** BMNH 1994.5.22.7.

ADDITIONAL MATERIAL: BMNH 1994.5.22.11 (fragment of OCDN 120-O): west side of Nama Island, 30 nautical miles east of Chuuk Atoll, Micronesia, 6°59.70'N, 152°34.40'E, 10m, collected by P. L. Colin, CRRF, 3 June 1992; BMNH 1994.5.22.9 (fragment of OCDN 321-I): oceanside reef, south of northeast Pass, Chuuk Atoll, Micronesia, 7°29.55'N, 151°59.10'E, 12m, collected by P. L. Colin, CRRF, 8 July 1992; BMNH 1994.5.22.19 (fragment of SIO-POH 93-005), Pohnpei, Micronesia, collected by Mary Kay Harper, SIO; BMNH 1994.6.14.1 (fragment of OCDN 2503-G): South Pass Pinnacle, west of South Pass, Chuuk Atoll, Micronesia, 30m, 7°13.49'N; 151°46.25'E, collected by P. L. Colin and P. Schupp, CRRF, 14 June 1994.

DESCRIPTION

Sub-spherical, solitary sponges (Fig. 5B), 6–8cm diameter, frequently coalescent with adjacent sponges forming a spreading mat up to 60cm wide (Fig. 5C). Surface with low blunt conules 1–5mm high, separated by 5–7mm, sponge smooth, rubbery, ostia in differentially pigmented stellate depressions. Oscules, apical, single or aligned in rows, with raised cream-coloured rims. Texture, compressible but firm, elastic. Colour in life, dull rose (9D6) mottled with oxblood red (9E6), large irregular areas and ostial depressions are oak brown (5D6). Colour of oscule rims cream (4A2), in ethanol, uniformly dull yellowish brown (5B4).

Skeleton: Arrangement plumoreticulate, with very thick rigid multispicular fibres, 500–1225µm diameter. Secondary fibres, 100–200µm diameter, sparse, connect primary fibres to form an extremely elongate mesh. Megascleres, arranged parallel to axis of fibre, spongin barely visible, largest fibres are hollow. Megascleres, scattered interstitially in choanosome. Curved branched tracts, 10–30µm diameter, emanate from tips of primary fibres, diverge and ramify dendritically through ectosome towards surface, forming fanned brushes (Fig. 6B). Megascleres form a sparse erect to fanned palisade in outer ectosome, juxtaposed upon primary fibre brushes. Thicker category of spinorhabds, found occasionally within megasclere surface brushes, lining ectosomal lacunae in greater density, and

are common within choanosome, particularly lining canals. Thinner microscleres, found only below lower ectosomal boundary. Ectosome, 1225 to 1700µm deep. Choanocyte chambers, approximately 25µm diameter.

Spicules. Megascleres. (Table 1): Subtylostrostrongyles: 273(240–300) × (3–5)µm, n=50.

Microscleres. (Table 1): Spinorhabd I: extremely fine with bumps or very short spines scattered irregularly along shaft: 45(36–50) × <1µm, n=50 (Fig. 7B); Spinorhabd II: straight, with distinct short spines along shaft, in four whorls, or irregularly distributed spines (Fig. 8B). Degree of spination varies between specimens: 45(40–60) × 1–3µm, n=100.

GEOGRAPHIC DISTRIBUTION

Chuuk Atoll, Nama Island, and Pohnpei Island, Micronesia (Fig. 4B).

SUBSTRATE, DEPTH RANGE, ECOLOGY

Common on oceansides of atoll and island fringing reefs down to 30m, growing openly under full illumination.

ETYMOLOGY

For Lori J. Bell, Coral Reef Research Foundation, Chuuk, Micronesia.

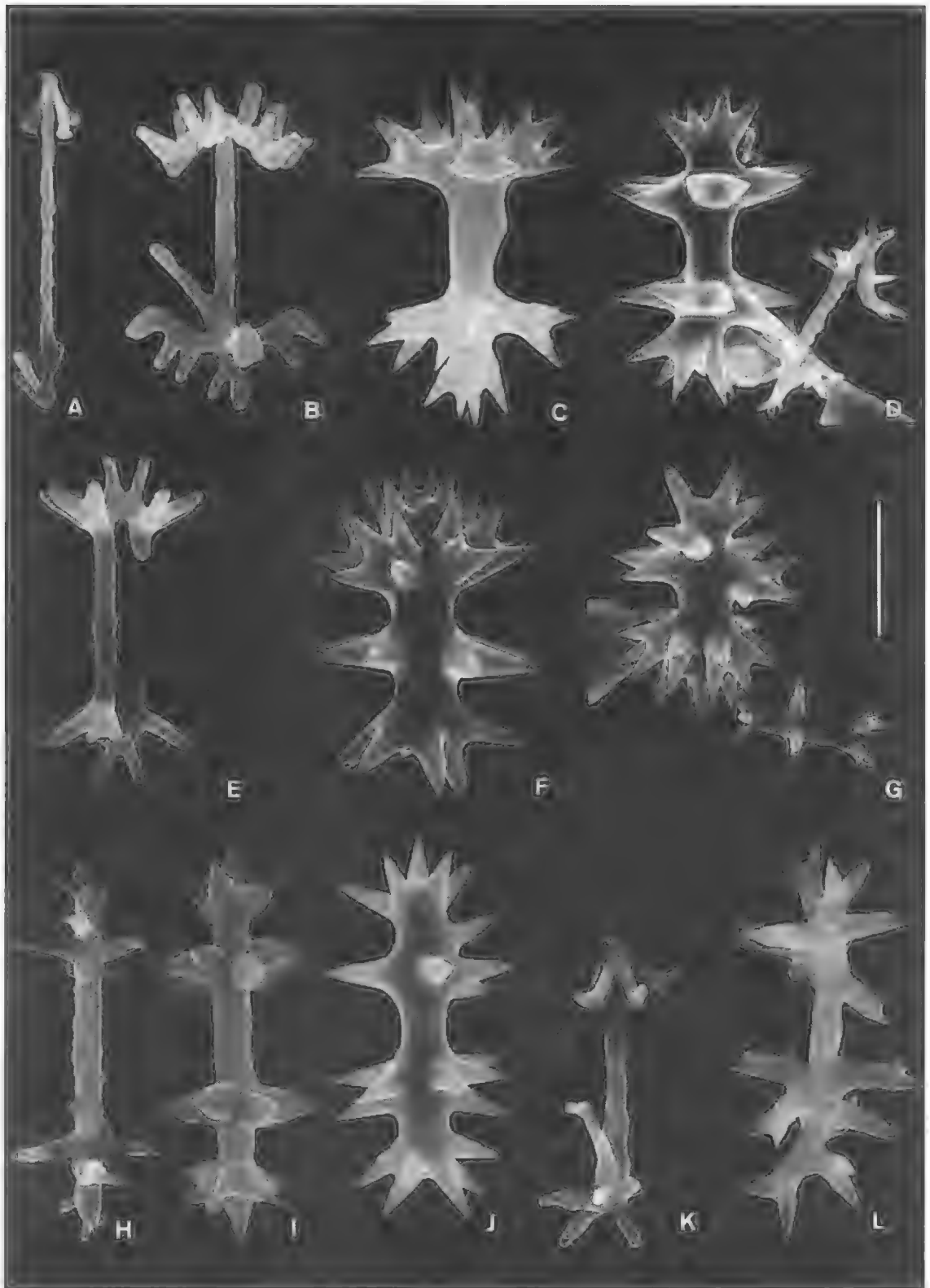
REMARKS

Diacarnus bellae and *D. spinipoculum* are very similar histologically, although the megascleres and microscleres are consistently slightly smaller and thinner in *D. bellae*. The two species can be easily differentiated by their gross morphology, however. *Diacarnus spinipoculum* is a very large barrel-shaped sponge with a wide, deep, central atrium lined with exhalant apertures. *Diacarnus bellae* is never tubular and occurs consistently in the field as a small solitary, semi-spherical sponge, or as several which coalesce to form a loose cluster. There is no suggestion of an apical atrium in *D. bellae*, the oscules are small and arranged serially or in clusters around the apex of each sponge.

***Diacarnus erythraeanus* sp. nov.**
(Figs 4C, 5D, 5E, 6C, 7C; Table 2)

MATERIAL EXAMINED

HOLOTYPE: QMG305008: near northern entrance of Obhor Creek, 30m, Djeddah, Red Sea, 21°50'N, 39°10'E, collected by J. Vacelet, 23 February 1983; **FRAGMENT OF HOLOTYPE:** BMNH 1995.6.26.1; MNHN DJV51.



ADDITIONAL MATERIAL: MNHN DJV52: fore reef zone, free living on the sand and embodying a piece of rope, 30m, King Saud Palace, Djeddah, 21°70'N, 38°80'E, collected by J. Vacelet, 8 March 1983; BMNH 1994.5.22.17: Râs Muhammad, 2-10m, South Sinai, Red Sea, dry specimen collected by Loya, 1977 (Loya 11); MNHN DJV53: Râs Muhammad, South Sinai, Red Sea, collected by Loya, 1978 (Loya 254); MNHN DJV54: Harvey Reef, 10m, near Port Sudan, collected by C. Wilkinson, August 1978; BMNH 1978.12.14.2: Harvey Reef, 10m, near Port Sudan, C. Wilkinson, August 1978.

DESCRIPTION

Repent or erect branches, 20-30mm diameter (Fig. 5D), variable length and branching pattern, often with slightly enlarged ends up to 50mm diameter, often anastomosing to form a sprawling mass up to 1m diameter, frequently free living on sand (Fig. 5E) or attached to debris. Texture, tough, just compressible, elastic. Surface, irregular with broad blunt conules, 2 mm high, on ends of branches. Ostia, 40-60µm diameter, localized in groups of about 10 in small surface depressions. Oscules, 2-3mm diameter, found on upper surface of branches or at tips of enlarged branch ends when in upright position, opening at end of raised cream-coloured fleshy collars. Colour, rose pink (9D6), mottled with oak brown (5D6) on surface, darker brown in approximately hexagonal concave depressions surrounded by cream ridges, more uniformly brown near end of branches. Interior in life and whole sponge in ethanol, cream (4A2).

SKELETON

Primary fibres, 500-800µm diameter, up to 1800µm in centre of branch, radiate towards sponge surface, connected by sparse short secondary fibres, 270-420µm diameter. Megasccleres, scattered interstitially in choanosome, Curved tracts, 30-50µm diameter, less than 20µm diameter when crossing ectosome-choanosome boundary, emanate from tips of primary

fibres, diverge and ramify dendritically through ectosome, occasionally dividing just below surface, giving rise to brushes (Fig. 6C). Megasccleres, form an erect to fanned palisade juxtaposed upon ectosomal brushes. Spinorhabds, rarely present, distributed just below the ectosome in upper choanosome, larger category absent. Ectosome, 600-900µm deep, distinct, rubbery. Choanocyte chambers, approximately 25µm diameter.

Spicules. *Megasccleres* (Table 2). Subtylostrogyles, straight, with a very faint swelling of proximal end, distal end rounded: 240(190-269) x (2.5-4.8)µm, n=30.

Microsccleres (Table 2). Spinorhabds I: straight, with occasional swellings or short spines scattered along shaft and near apices, occasional to rare: 25(24-30) x 0.8-1.3µm, n= 25 (Fig. 7C).

GEOGRAPHIC DISTRIBUTION

South Sinai, Eilat, Harvey Reef off Port Sudan, Red Sea (Fig. 4C)

SUBSTRATE, DEPTH RANGE, ECOLOGY

Common on coral substrate or rocks, large specimens, free living or attached to small corals fragments in sand. Depth range, 10-30m, although reported to be very common at Eilat in shallow water of 2-10m (Loya, pers. comm. 1978). Parenchymella larvae, 2mm diameter, within choanosome of MNHN DJV52.

ETYMOLOGY

The species name indicates that the sponge is found only in the Red Sea.

REMARKS

This sponge is easily recognised in the field by its external morphology of repent anastomosing branches, mottled surface colouration, conulose surface and smooth rubbery texture, and tough internal fibres. The small thin spinorhabds are

FIG. 3. Comparison of the developmental and mature stages of spinorhabd microsccleres of *Sigmosceptrella*, *Diacarnus* and *Negombata*. A-D, *Sigmosceptrella fibrosa*, Dendy (BMNH 1925.11.1.717), Maria Island, Tasmania: A, B, rhabd in earliest stage with strongly recurved spines similar to those of *Negombata magnifica* (K-L). C, the maturing spinorhabd shows signs of the fused recurved spines on the shaft, D, mature spinorhabd with a distinctly sigmoid rhabd on the right. Scale: A: 9.1µm; B: 6µm; C: 10.4µm; D: 18.2µm. E-G, *Sigmosceptrella quadrilobata* Dendy (E-100, X-371), Tuléar, Madagascar. E, specimen E-100, sigmoid rhabd. F, specimen X-371, mature spinorhabd. G, specimen X-371, mature spinorhabd with post-fusion sigmoid rhabd. Scale: E: 9.1µm; F: 16.5µm; G: 18.2µm. H-J, *Diacarnus ardoukobae* sp. nov., holotype QMG305010. H, spinulate rhabd. I, maturing spinorhabd. J, mature spinorhabd. Scale: H: 9.1µm; I: 18.8µm; J: 14.6µm. K-L, *Negombata magnifica* (Keller), MNHN DJV 56. K, rhabd with irregular sharply re-curved spines. L, mature spinorhabd. Scale: K: 5.2µm; L: 8µm.

TABLE 2. Spicule dimensions of *Diacarnus erythraeanus* sp. nov., given as mean length (range), width, all in μm .

Sample	Megascleres	Spinorhads I
<i>Diacarnus erythraeanus</i> QMG305007 Holotype	253(200-285) (2.6-3.5)	23.3(15-27.5) (1)
MNHN DJV52	273(235-325)	22.5 (20-25) rare
MNHN DJV53	258(195-290)	24.7(10-30)
BMNH 1994.5.22.17	251(200-300) (2.5-2.7)	23.7(12.5-30) rare (0.8-1.3)
MNHN DJV54	249(210-269) (2.4-4.8)	absent
BMNH 1978.12.14.2	243(211-269) (2.4-4.8)	absent

rare and are easily overlooked in spicule preparations and histological sections.

Diacarnus levii sp. nov.
(Figs 4A, 5F, 6D, 7D; Table 3)

MATERIAL EXAMINED

HOLOTYPE: QMG305009: (ORSTOM R1524), St. 478, lagoon, Belep, New Caledonia, 4-25m, 19°34.03'S, 163°42.03'E, 8 March 1990; FRAGMENT OF HOLOTYPE: BMNH 1994.5.22.16; MNHN DCL3659.

ADDITIONAL MATERIAL: MNHN DCL3660: (ORSTOM R767), St. 206, Banc de la Torche, New Caledonia, 35m, 22°56.60'S, 167°40.00'E; MNHN DCL3661: (ORSTOM R879), St. 184, 18-25m, lagoon ilot Ua, New Caledonia, 22°43.00'S, 166°49.10'E, 28 June 1979; MNHN DCL3662: (ORSTOM R994), St. 225, 42m, Canala Pass, New Caledonia, 21°18.80'S, 165°57.25'E; MNHN DCL3663: (ORSTOM R1247), St. 270, 8m, Kouare lagoon, New Caledonia, 22°46.50'S, 166°47.90'E, 3 March 1980; MNHN DCL3664: (ORSTOM R1291), St. 303, 6m, fore-reef zone, Cook Reef, New Caledonia, 19°45.60'S, 161°41.40'E, 23 June 1981; MNHN DCL3665: (ORSTOM R1528), St. 448, 6-15m, fore-reef zone, Abore reef, New Caledonia, 22°20.00'S, 166°13.15'E; BMNH 1994.5.22.15 (fragment of Q66C-0248): west side of seaward vertical wall of reef, 18m, Big Broadhurst Reef, Great Barrier Reef, Australia, 18°56.67'S, 147°43.86'E; BMNH 1994.5.22.8 (fragment of Q66C-0890): Black Reef, Whitsunday Islands, Great Barrier Reef, 10m, collected by M. Kelly-Borges, 20 October 1987.

DESCRIPTION

Thick erect digitations or lobes, 30-45mm diameter, anastomosing in large masses (Fig. 5F). Texture, tough, just compressible, elastic. Surface, with low rounded conules, approximately 2 mm high, 2-5mm apart. Ostia, 50 μm diameter,

found in small, darker surface depressions. Oscules, on apices of digitations, surrounded by a white margin, 10mm diameter in preserved specimens. Surface with rounded depressions containing ostia in stellate arrangement. Colour in life oak brown (5D6), darker in ostial depressions, mottled with cream (4A2) in surface patches and around oscule margin; cream interior, uniformly white in ethanol.

Skeleton. Plumoreticulate arrangement with very thick multispicular fibres, 700-1125 μm diameter, joined by small short secondary fibres, 250-375 μm diameter, at right angles to primary fibres (Fig. 6D). Small dendritic tracts, 30-50 μm diameter, emanate from tip of fibre, dividing and radiating through ectosome toward surface, ending in narrow brushes, surface raised in large blunt conules. Megascleres form an erect palisade at surface. Interstitial megascleres, abundant. Spinorhads, rare, found only in superficial layers of choanosome when present. Ectosome, thick, 500-1100 μm , composed of parallel collagen fibrils in wavy bundles. Choanocyte chambers, 20 to 25 μm diameter.

Spicules. *Megascleres.* (Table 3); Subtylostrongyles, with slight swelling at proximal end: 258(210-300) \times 2-5 μm , $n=30$.

Microscleres. (Table 3): Spinorhabd I: straight, with swellings or small, irregular spines usually more developed near apices, always rare, may be absent in some specimens: 58(53-60) \times 0.5-2.4 μm , $n=10$ (Fig. 7D).

SUBSTRATE, DEPTH RANGE, ECOLOGY

Found on fringing coral reef slopes down to 35m. Large embryos or parenchymella larvae, up to 1.5mm diameter, white or yellow in the choanosome, are observed in all specimens.

GEOGRAPHIC DISTRIBUTION

New Caledonia; northeastern Great Barrier Reef, Australia (Fig. 4A)

ETYMOLOGY

For Professor Claude Lévi.

REMARKS

Diacarnus levii appears to be fairly common in New Caledonia, but has only been collected from two locations on the Great Barrier Reef. In both locations the sponge was rare. Specimens from the Whitsunday Islands and Big Broadhurst Reef, Australia, have slightly larger megascleres and the spinorhads are slightly thicker with better developed spines, however, they are similar to the

TABLE 3. Spicule dimensions of *Diacarnus levii* sp. nov., given as mean length (range), width (range), all in μm .

Sample	Megascleres	Spinorhads I
<i>Diacarnus levii</i> Holotype QMG305009	247(190-280) (2.4-3.0)	59(55-62.5) (0.5-1.0)
MNHN DCL3663	248(245-315) (2.5-3.0)	not found
MNHN DCL3665	252(211-278) (2.4-5.0)	59(58-60) rare (0.5-1.0)
BMNH 1994.5.22.15	245(240-288) (2.0-5.0)	58(53-60) (0.5-1.0)
BMNH 1994.5.22.8	266(240-288) (2.0-5.0)	57(53-60) (0.5-1.0)

New Caledonian specimens in all other aspects. *Diacarnus levii* is differentiated from the Red Sea species, *D. erythraeanus*, by gross morphology; *D. levii* is more massive than *D. erythraeanus* which is ramose and branching. The major spicule difference between *D. levii* and *D. erythraeanus* is that the spinorhads in the former are almost twice as long as those of *D. erythraeanus*.

Diacarnus ardoukoba sp. nov.
(Figs 3H, 3I, 3J, 4C, 5G, 6E, 7E, 8C)

MATERIAL EXAMINED

HOLOTYPE: QMG305010, Musha island, Djibouti, Gulf of Aden, 11°42.50'N, 43°08.40'E, fore reef zone, several specimens observed, some free living on sand, 24m, collected by J. Vacelet, 5 January 1985 (M 8); FRAGMENT OF HOLOTYPE: BMNH 1994.5.22.14, MNHN DJV55.

DESCRIPTION

Curved erect or repent branches (Fig. 5G), separate or forming a sprawling mass up to approximately 50cm long, uniform 1.5-2.0cm diameter. Ends of branches markedly conulose, branch surfaces irregularly bumpy with occasional conules, texture compressible, rubbery. Oscules distributed along branches rather than at tips of branch. Colour in life pale pink mottled with dark pink in surface depressions, uniformly cream in ethanol (4A2).

Skeleton. Primary fibres, 300-1000 μm diameter, radiate towards sponge surface, connected by abundant secondary fibres, 60-300 μm diameter. Six to ten short compact fibres, 30-70 μm diameter, radiate from tip of primary fibre, occasionally branching to form irregular sparse surface brushes (Fig. 6E). Megascleres form an irregular and often paratangential palisade between fibres.

Megascleres, abundant in choanosome. Ectosome, generally 300 μm deep, ranging from 120 to 540 μm . Microscleres, two categories, smaller dispersed under ectosome-choanosome boundary, larger microscleres form a dense layer in middle of ectosome (Fig. 6E), scattered throughout choanosome particularly around canals, never found on the outer layer of ectosome.

Spicules. *Megascleres:* Subtylostrostrongyles: 255(220-288) \times 2.4-6 μm , $n=30$.

Microscleres. Spinorhabd I: spines are very irregular in shape and disposition, terminal spines occasionally bifurcate, central shaft bumpy, two major whorls of spines are evident, and closer to ends of spicule rather than regularly spaced along axis as in second category: 29(24-34) \times 2.4 μm (Fig. 3H, 7E); Spinorhabd II: conical spines are typically disposed in irregular whorls along shaft, inner two being usually a greater distance apart than each are to terminal spine cap (Fig. 3I, 3J, 8C). Terminal spine cap and outer whorl frequently merge, these spicules are often shorter than those with equally spaced whorls: 54(48-67) μm , $n=10$, total maximum width 19-31 μm , shaft diameter 2-4.5 μm .

GEOGRAPHIC DISTRIBUTION

Known only from Djibouti, Gulf of Aden (Fig. 4C).

SUBSTRATE, DEPTH RANGE, ECOLOGY

Specimens free-living on sand at 24m deep. Reproductive mode, possibly fragmentation and release of parenchymella larvae as in other species of *Diacarnus*.

ETYMOLOGY

For the "Ardoukoba" expedition during which specimens were collected.

REMARKS

External morphology is similar to *D. erythraeanus*, which is also ramose and branching. This latter species forms mats of anastomosing branches which typically have enlarged ends upon which the oscules are located. Specimens of *D. ardoukoba* are separate, elongate branches, uniform in diameter, with flush oscules along each branch. Histologically, *D. ardoukoba* is distinct from *D. erythraeanus*, as it has a comparatively thin ectosome and less robust fibres which form a rather tighter meshed skeleton than in *D. erythraeanus*. The fibres which diverge from the apex of the primary fibres in *D. ardoukoba* are comparatively thick and short and much reduced

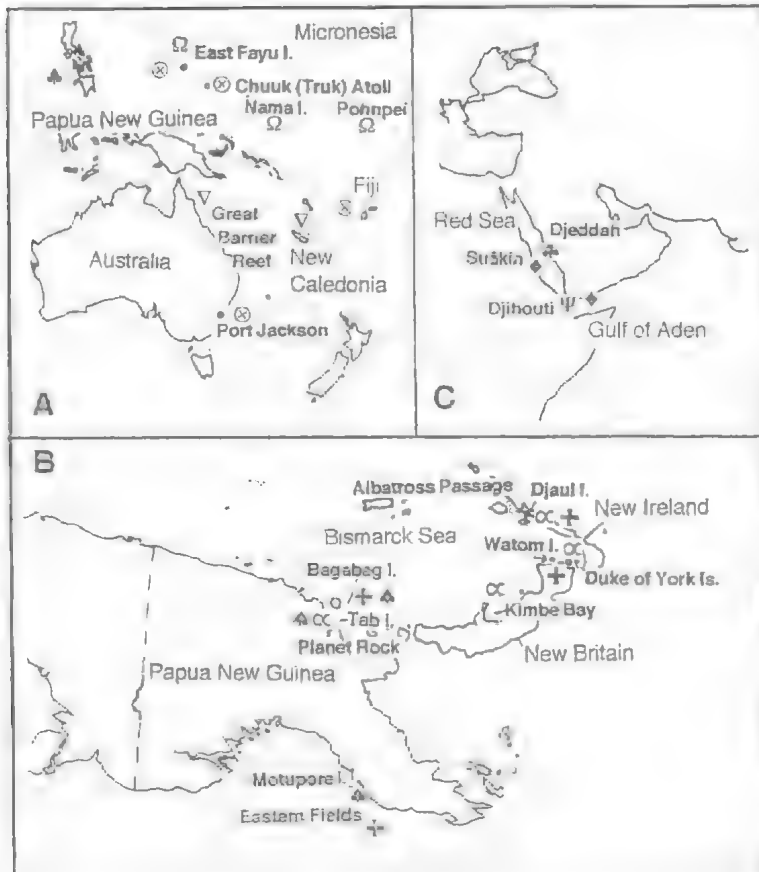


Fig. 4. Geographic distribution of *Diacarnus* spp. and *Negombata* spp. A. Indo-West Pacific and Australia: ⊗ *Diacarnus spinipoculum* (Carter); Ω *Diacarnus bellae* sp. nov.; ∇ *Diacarnus levii* sp. nov.; ▲ *Diacarnus megaspinorhabdosa* sp. nov. B. Papua New Guinea: × *Diacarnus bismarckensis* sp. nov.; + *Diacarnus tubifera* sp. nov.; ♣ *Diacarnus megaspinorhabdosa* sp. nov. C. Red Sea and Gulf of Aden: ⬤ *Diacarnus erythraeanus* sp. nov.; ♣ *Diacarnus ardoukoba* sp. nov.; ♦ *Negombata magnifica* (Keller).

in number compared to those of *D. erythraeanus*. The major difference on which these two species are separated, however, is the presence of a second category of spinorhabd - a larger, more robust and heavily spined microscle, which is disposed in a mid-ectosomal layer.

***Diacarnus bismarckensis* sp. nov.**
(Figs 4B, 5H, 6F, 7F, 8D)

MATERIAL EXAMINED

HOLOTYPE: QMG305011: (fragment of OCDN 705-Y): Planet Rock, 15m, south of Madang, northern Papua New Guinea, 5° 15.475'S, 145° 49.12'E, col-

lected by P. L. Colin, CRRF, 6 November 1992; **FRAGMENT OF HOLOTYPE:** BMNH 1994.5.22.13.

ADDITIONAL MATERIAL: BMNH 1994.5.22.12 (fragment of OCDN 754-C): Banban reef (uncharted), 20m, Kimbe Bay, West New Britain, Papua New Guinea, 4° 55.53'S, 150° 55.51'E, collected by P. L. Colin, CRRF, 14 November 1993; BMNH 1993.11.5.1: oceanside of Makada Reef, 15m, Duke of York Islands, East New Britain, Papua New Guinea, 4° 6.68'S, 152° 23.87'E, collected by P. L. Colin, CRRF, 5 November 1993; BMNH 1993.10.29.1: overhang on outer reef near Albatross Passage, 6-12m, north-western New Ireland, Papua New Guinea, 2° 45.23'S, 150° 43.24'E, collected by P. L. Colin, CRRF, 29 October 1993; BMNH 1993.11.1.1: south coast wall near east end of Djaul Island, western New Ireland, Papua New Guinea, 2° 58.69'S, 150° 59.33'E, collected by P. L. Colin, CRRF, 1 November 1993.

DESCRIPTION

Ramose, each branch 1-2cm diameter, approximately 30cm length, branches anastomosing, forming large clumps hanging off overhangs or growing erect from coral surface (Fig. 5H). Texture, slightly compressible, difficult to tear, rubbery. Surface, conulose but microscopically smooth. Colour in life cream flecked with garnet-brown (9D7) and copper red (7C7), tips and undersides pale cream. Ostia, set in garnet

brown stellate surface depressions, set in a paler copper red surrounding.

Skeleton. Primary fibres, 300-600µm diameter, run parallel with branch, connected by perpendicular short secondary fibres, 120-300µm diameter (Fig. 6F). Dendritic fibres, 30-50µm diameter, radiate from tip of primary fibre, occasionally branching, forming surface brushes. Interstitial megascleres, abundant in choanosome. Ectosome, 300-450µm deep on sides of branches. Larger category of spinorhabds distributed in an ordered layer just below surface of sponge, abundant in choanosome and along ectosome-choanosome boundary in places (Fig. 6F).

Spicules. *Megascleres.* Subtylostrostrongyles: 274(250-320) x 2.5-8µm, n=30.

Microscleres. Spinorhabd I: spines are relatively regular in shape, disposed in four equidistant, frequently incomplete whorls: 39(33-48) x 2.4µm (Fig. 7F). Spinorhabd II: sharp conical spines of equal length, disposed in regular whorls along shaft, each equidistant from the other: 58(46-67)µm, n=10, total maximum width 14-26µm, shaft diameter 5-10µm (Fig. 8D).

GEOGRAPHIC DISTRIBUTION

Bismarck Sea (Fig. 4B), very common on barrier patch reefs of western New Ireland, New Britain, and Madang, north coast of mainland Papua New Guinea, particularly common around Djaul Island off the northwest tip of New Ireland (L. J. Bell, pers. comm. 1994).

SUBSTRATE, DEPTH RANGE, ECOLOGY

Found predominantly on ledges, overhangs, on cave walls within 10 to 30m. Reproduction by production of large yellow-pigmented larvae.

ETYMOLOGY

For the Bismarck Sea.

REMARKS

General morphology, growth form, and colouration of this northern Papua New Guinean species is remarkably similar to that of *Diacarnus ardoukoba* from the Gulf of Aden. Both are ramose, have a relatively thin ectosome, and possess a second larger category of spinorhabd disposed in a central to upper ectosomal layer and throughout the choanosome. The major difference between these two species is the spicule size and morphology of the largest spinorhabds. *Megascleres* and *microscleres* in *D. bismarckensis* are longer than in *D. ardoukoba*, and the latter are more abundant in *D. bismarckensis*. In *D. bismarckensis*, *microsclere* spines are very regular, of equal length, and disposed equidistantly along the shaft of the spicule. In *D. ardoukoba*, spines are irregular, with the central whorl of spines being longer, and disposed closer to the ends of the spinorhabd. These differences are also apparent in the smaller spinorhabds of *D. ardoukoba*.

***Diacarnus tubifera* sp. nov.**
(Figs 4B, 5I, 5J, 6G, 7G, 8E)

MATERIAL EXAMINED

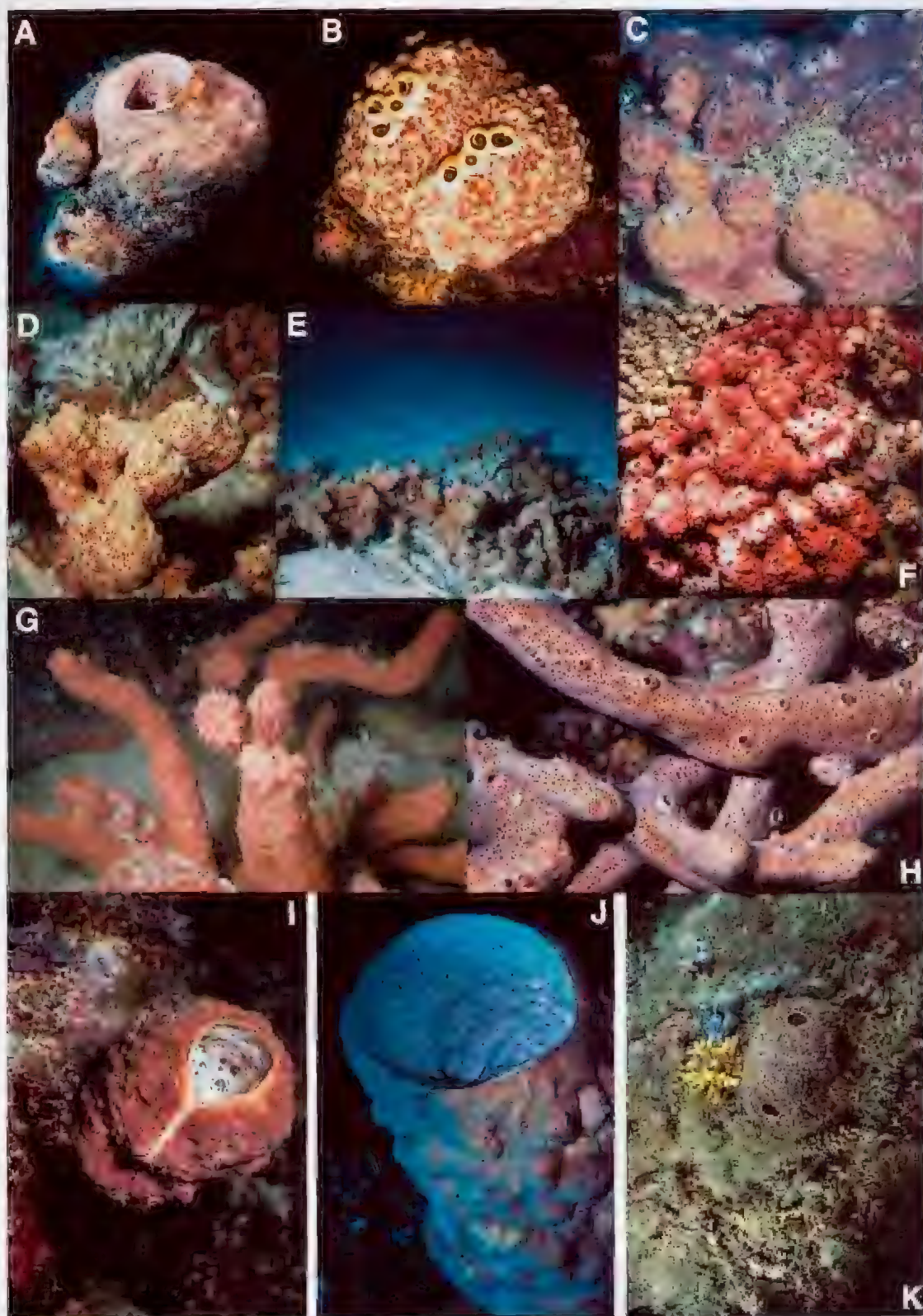
HOLOTYPE: QMG305012: oceanside reef near Pizion Island, Chuuk Atoll, Micronesia, 45m, 7° 11.10'N, 151° 50.20'E, collected by P. L. Colin, CRRF, 7 January 1994; **FRAGMENT OF HOLOTYPE:** BMNH 1994.5.22.2

ADDITIONAL MATERIAL: BMNH 1994.5.22.1: west side of East Fayu Island, 30.5m, 60nautical miles north-northwest of Chuuk Atoll, Micronesia, 8° 32.61'N, 151° 20.01'E, collected by P. L. Colin, CRRF, 14 January 1994; BMNH 1994.5.22.10 (fragment of OCDN 716-M): west side of barrier reef surrounding Bagabag Island, 28m, 30nautical miles offshore on northern Papua New Guinea coastline, 4° 47.15'S, 146° 10.96'E, collected by P. L. Colin, CRRF, 9 November 1993; Q66C-6138: attached to vertical wall, 40m, "The Grotto", southeast Watom Island, off western coast of New Britain, Papua New Guinea, 4° 6.2'S, 152° 5.7'E, collected by M. Kelly-Borges, 16 October 1991; BMNH 1993.11.1.2: south coast wall near east end of Djaul Island, western New Ireland, Papua New Guinea, 2° 58.69'S, 150° 59.33'E, collected by P. L. Colin, CRRF, 1 November 1993.; BMNH 1993.10.22.1: oceanside of Eastern Fields Atoll, 9m, Coral Sea, 90 miles southwest of Port Moresby, southern Papua New Guinea, 10° 00.80'S, 145° 40.24'E, collected by P. L. Colin, CRRF, 22 October 1993; BMNH 1995.7.4.5: Tubbataha Reefs, south of Cagayan Islands, Sulu Sea, Philippines, 8°40'N, 120°E, disturbed rubble and sand, 10m, collected by L. Sharron, 21 April 1995; BMNH 1995.7.4.3: Tubbataha Reefs, south of Cagayan Islands, Sulu Sea, Philippines, 8°40'N, 120°E, on vertical coral wall, 37m, collected by L. Sharron, 22 April 1995; BMNH 1995.7.4.2: Puerto Princessa, Palawan, Philippines, 9°50'N, 118°30'E, 12-18m, collected by P.L. Colin, 15 April 1995.

DESCRIPTION

Single tubular to vase-shaped, very heavy, thick-walled (Fig. 5I), average height 80cm, 15-30cm wide, most frequently twice as tall as wide, with large lobate processes on the outer surface, surface tuberculate. Atrium, apical, typically up to 15cm wide in vase-shaped sponges (Fig. 5J), typically about 8cm diameter in tubular sponges. Smaller specimens extremely conulose, often 10-14cm diameter, 9-10cm high, with a 5cm wide atrium. Texture, very firm, rubbery, mesohyl matrix very dense, fleshy. Colour in life carrot red (6B7) mottled with bright reddish brown (9D8), very patchy, interior of tube bright white, beige in ethanol.

Skeleton. Primary fibres, 450-600µm diameter, sparse, run longitudinally, anastomosing along axis of tubular body towards sponge apex. Large



branches, 150–300 µm diameter, emerge some distance below ectosome-choanosomal boundary from upper 5–10 mm of primary fibre. Fibre extensions radiate towards sponge surface, branching many times before entering ectosome (900–2400 µm deep; average depth 1500 µm, with lacunae 30–60 µm wide), forming an immense number of very fine, long, dendritic fibres which meander through choanosome and ectosome ultimately forming small surface brushes in outer ectosome (Fig. 6G). Immense umbells raise surface into rounded lobes. Abundant megascleres form a palisade superimposed over the surface brushes. Primary fibres anastomose, also connected by short secondary fibres 120–300 µm diameter. Interstitial megascleres, abundant, arranged in loose broad bundles between primary fibres. Large spinorhabds, scattered in outer ectosome, slightly more abundant in outer third of ectosome, absent from outer 50 µm, common throughout choanosome. Megascleres and microscleres abundance variable between specimens. Smaller category of spinorhabds dispersed under ectosome-choanosome boundary.

Spicules. **Megascleres.** Subtylostrogonyles: 304(250–345) × 2.5–5 µm, n=30.

Microscleres. Spinorhabd I: extremely fine with fine spines dispersed along shaft: 38(38–41) × 2.5 µm, n=10 (Fig. 7G); Spinorhabd II: distinct whorls of spines: 60(55–67) × maximum width 17–19 µm, shaft width 3.5–5 µm, n=30 (Fig. 8E).

GEOGRAPHIC DISTRIBUTION

Chuuk Atoll and East Fayu Island, Micronesia; Bismarck Sea, widely and sparsely distributed on barrier patch reefs of western New Ireland and New Britain, and Madang on northern coast of mainland Papua New Guinea (L. J. Bell, pers. comm.); Eastern Fields Atoll, southern Papua New Guinea (Fig. 4B).

SUBSTRATE, DEPTH RANGE, ECOLOGY

Solitary and uncommon in any one locality, they are found on vertical walls and steep-sloped oceanic fringing reefs to depths of 45 m. Mode of

reproduction not observed, sponge surface frequently completely infested with barnacles.

ETYMOLOGY

Reflects the consistently tubular morphology.

REMARKS

Diacarnus tubifera is conspicuous and easily recognised in the field as large long solitary or double tubes, with an extremely heavy, rubbery texture. Smaller specimens are also tube-shaped and extremely conulose, also with a deep central atrium. Histologically, the sponge is well differentiated from all species described thus far. The sponge has a very thick ectosome which is ramified with abundant dendritic fibres which emanate well within the choanosome, arising to form a lobed surface. The megascleres and large category of spinorhabds are larger than in previously described species, and the large spinorhabds are scattered throughout the ectosome rather than being restricted to a distinct mid-ectosomal band such as in *D. ardoukobae* and *D. bismarckensis*.

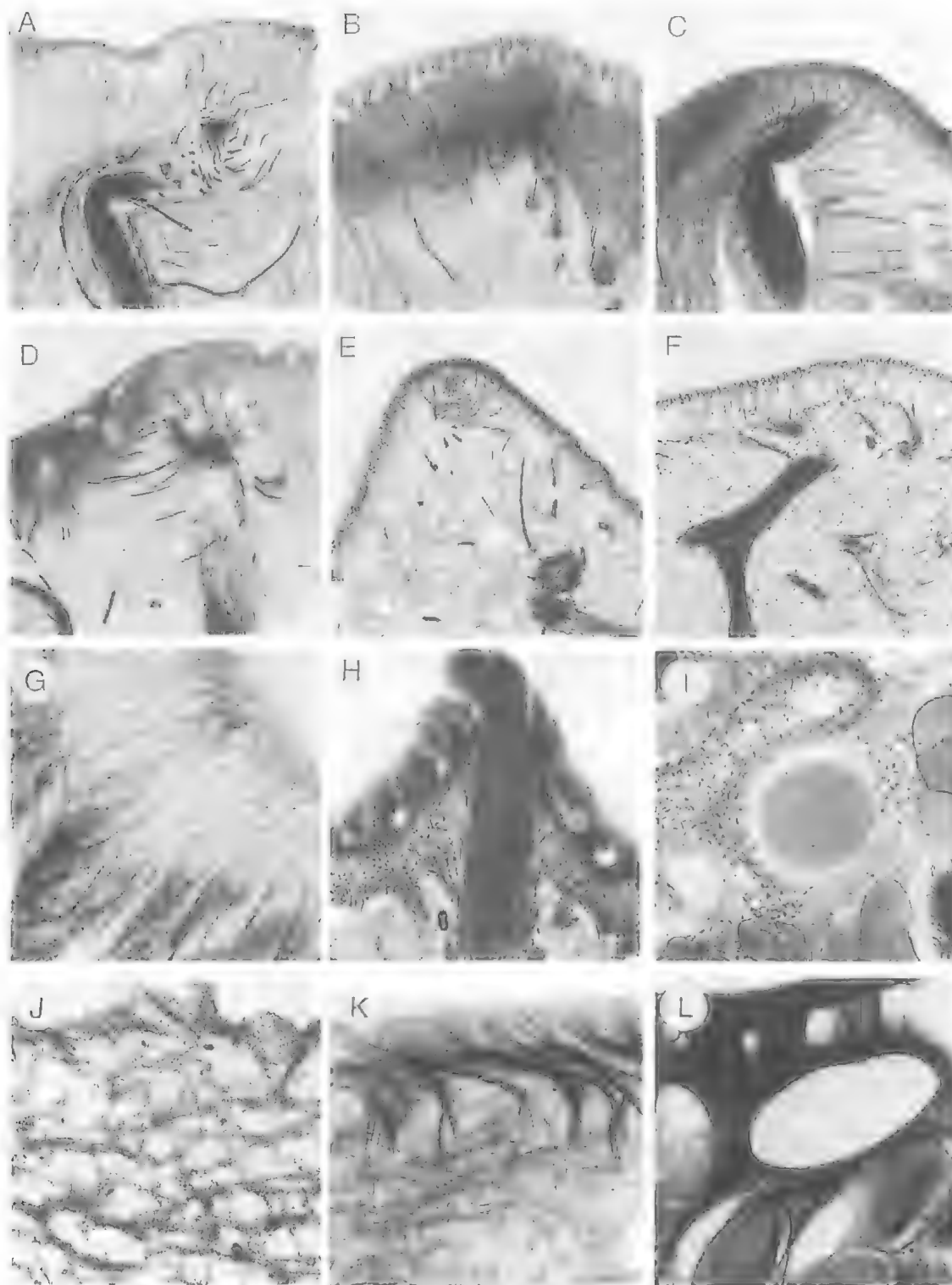
***Diacarnus megaspinorhabdosa* sp. nov.**
(Figs 4B, 5K, 6H, 6I, 7H, 8I)

MATERIAL EXAMINED

HOLOTYPE: QMG305013: fringing reef 150 m south of Motupore Island, 10 m, Bootless Bay, Papua New Guinea, 9° 31.6'S, 147° 16.6'E, collected by M. Kelly-Borges, 6 December 1985; **FRAGMENTS OF HOLOTYPE:** BMNH 1994.5.22.6, NSRC(UPNG) 90.

ADDITIONAL MATERIAL: BMNH 1994.5.22.5: (fragment of OCDN 673-P): lagoon side of Tab (Pig) Island, 10 m, on Madang barrier reef, Papua New Guinea, 5° 10.21'S, 145° 50.37'E, collected by P. L. Colin, CRRP, 3 November 1992; HBOM 003:00925: fringing reef south of Motupore Island, 10 m, Bootless Bay, Papua New Guinea, 9° 31.6'S, 147° 16.6'E, collected by M. Kelly-Borges, 24 January 1994; BMNH 1994.7.25.1 (fragment of OCDN 2693-M): attached to rubble, 7 m, Gamao Point, Batangas, Philippines, 13° 38.39'N, 120° 56.86'E, collected by C. Arneson, CRRP, 25 July 1994; BMNH 1995.5.7.4.1: Zambales, West Luzon, Philippines, 15° 50'N, 120°E, silty reef, 18 m, collected by P. L. Colin, 2 May 1995; BMNH 1995.7.4.4: Zambales, West Luzon, Philippines, 15° 50'N, 120°E,

FIG. 5. Species of *Diacarnus* in situ. See descriptions in text for size in life. A. *Diacarnus spumopachum* (Carter), Fiji, BMNH 1994.8.20.1. B–C. *Diacarnus bellae* sp. nov., Chuuk Atoll, Micronesia: B. solitary form, BMNH 1994.5.22.9. C. coalescent form, holotype QMG305007. D–E. *Diacarnus erythraenus* sp. nov., Djeddah, Red Sea, holotype QMG305008. F. *Diacarnus levii* sp. nov., Belep, New Caledonia, holotype QMG305009. G. *Diacarnus ardoukobae* sp. nov., Djibouti, holotype QMG305010. H. *Diacarnus bismarckensis* sp. nov., Djaul Island, Papua New Guinea, BMNH 1993.11.1.1. I. *Diacarnus tubifera* sp. nov., Djaul Island, Papua New Guinea. I. tubular form, BMNH 1993.11.1.2; J. vase-form. K. *Diacarnus megaspinorhabdosa* sp. nov., Batangas, Philippines, BMNH 1994.7.25.1.



43m, collected by P.L. Colin, 3 May 1995; BMNH 1995.9.1.1, BMNH 1995.9.1.2; south side of Puerto Princessa Bay, Puerto Princessa, Pallangbato, Philippines, 9°41.62'N, 118°4.51'E. Collected by P.L. Colin CRRF, 15 April 1995.

DESCRIPTION

Thickly encrusting, lobate, some specimens with restricted base of attachment, 6–15cm diameter, lobes up to 4cm high (Fig. 5K). Lobe apices covered in tough sharp conules approximately 2 mm high, 2–5mm apart. Oscules, 1–3mm diameter, with smooth raised cream collars, scattered apically on lobes or irregularly over surface. Texture, barely compressible, tough, harsh to touch but microscopically velvety between conules. Colour in life oxblood red (9E8), mustard (5C8) internally, uniformly cream (4A2) in ethanol. BMNH 1994.5.22.5 from Madang was pale brown (4B4) in life due to shading effects. Very large bright yellow embryos are abundant in BMNH 1994.5.22.6 (Fig. 6I).

Skeleton. Primary fibres, sparse, tough, up to 900µm diameter, raise surface into well-separated tough, sharply pointed conules (Fig. 6H). Primary fibres joined by short, very thick, secondary fibres, up to 500µm thick. Sparse spicule tracts, 60–100µm wide, diverge from primary fibre well within choanosome, branching, occasionally forming well separated tracts that radiate within ectosome. Tracts end in dense brushes at surface where they interdigitate with a dense loose palisade of megascleres. Interstitial megascleres, numerous in choanosome, dispersed without order between fibres. Larger fibres are surrounded by a sheath of bundles of collagen fibrils, 60–80µm thick, which also contains loose megascleres arranged longitudinally along fibre. Large spinorhabds, abundant in ectosome and disposed in an undulating band in upper portion of ectosome surrounding lacunae, also abundant above lower ectosomal boundary and abundant in choanosome, sometimes patchily, sometimes concentrated around canals (see Fig. 6I). Small spinorhabds, below ectosomal-choanosomal boundary.

Spicules. *Megascleres.* Subtylostongyles: 318(298–346) × 7–12µm, approximately 20µm shorter (average) in BMNH 1994.5.22.5 from Madang.

Microscleres. Spinorhabds I: slender rods with regular whorls of small spines; 48(43–55) × 3–5µm, shaft 1µm wide (Fig. 7H); Spinorhabds II: spines blunt, central shaft very thick, occasionally malformed with central shaft bare or spines re-curved along shaft; 84(74–96)µm, n=30, maximum width 36(34–48), shaft width: 15(10–19)µm (Fig. 8F).

SUBSTRATE, DEPTH RANGE, ECOLOGY

Found on silty, fringing coral reefs down to 10m. Choanosome contains large conspicuous embryos of parenchymella type, up to 1.5mm diameter. Easily observed in specimens in the field, they are bright orange-yellow, contrasting with cream mesohyal matrix, they are abundant, present at any time of collection. Larvae, loosely embedded within the central part of body (Fig. 6I), many contain thin megascleres dispersed without order in central region. Microscleres, absent from embryos. Round or ovoid inclusions, 50–80µm diameter, with a fibrillar content, abundant in the choanosome, possibly spermatocysts.

GEOGRAPHIC DISTRIBUTION

Northern (Madang), southern (Motupore Island) Papua New Guinea; Batangas, Philippines (Fig. 4B)

ETYMOLOGY

Reflects large size and abundance of largest category of spinorhabds.

REMARKS

The major character separating *Diacarnus megaspinorhabdosa* from other species of *Diacarnus* is the possession of extremely large spinorhabds, and the largest average megasclere dimensions. These microscleres form dense aggregations in the choanosome and are disposed in an upper and lower layer within the ectosome.

FIG. 6. A–L, Skeletal arrangements of *Diacarnus* and *Negombata* spp. A, *Diacarnus spinipoculum* (Carter), holotype BMNH 1846.10.14.174, 30 ×. B, *Diacarnus bellae* sp. nov., BMNH 1994.5.22.11, 30 ×. C, *Diacarnus erythraeanus* sp. nov., MNHN DJV52, 30 ×. D, *Diacarnus levii* sp. nov., holotype QMG305009, 30 ×. E, *Diacarnus ardoukobae* sp. nov., holotype QMG305010, 30 ×. F, *Diacarnus bismarckensis* sp. nov., BMNH 1994.5.22.12, 30 ×. G, *Diacarnus tubifera* sp. nov., BMNH 1994.5.22.10, 30 ×. H–I, *Diacarnus megaspinorhabdosa* sp. nov., holotype QMG305013. H, skeletal arrangement, 30 ×. I, larva, 120 ×. J, *Negombata corticata* (Carter), holotype BMNH 1840.5.6.56–58, 30 ×. K–L, *Negombata magnifica* (Keller): holotype fragment BMNH 1908.9.24.118, 30 ×. L, MNHN DJV56, 120 ×.

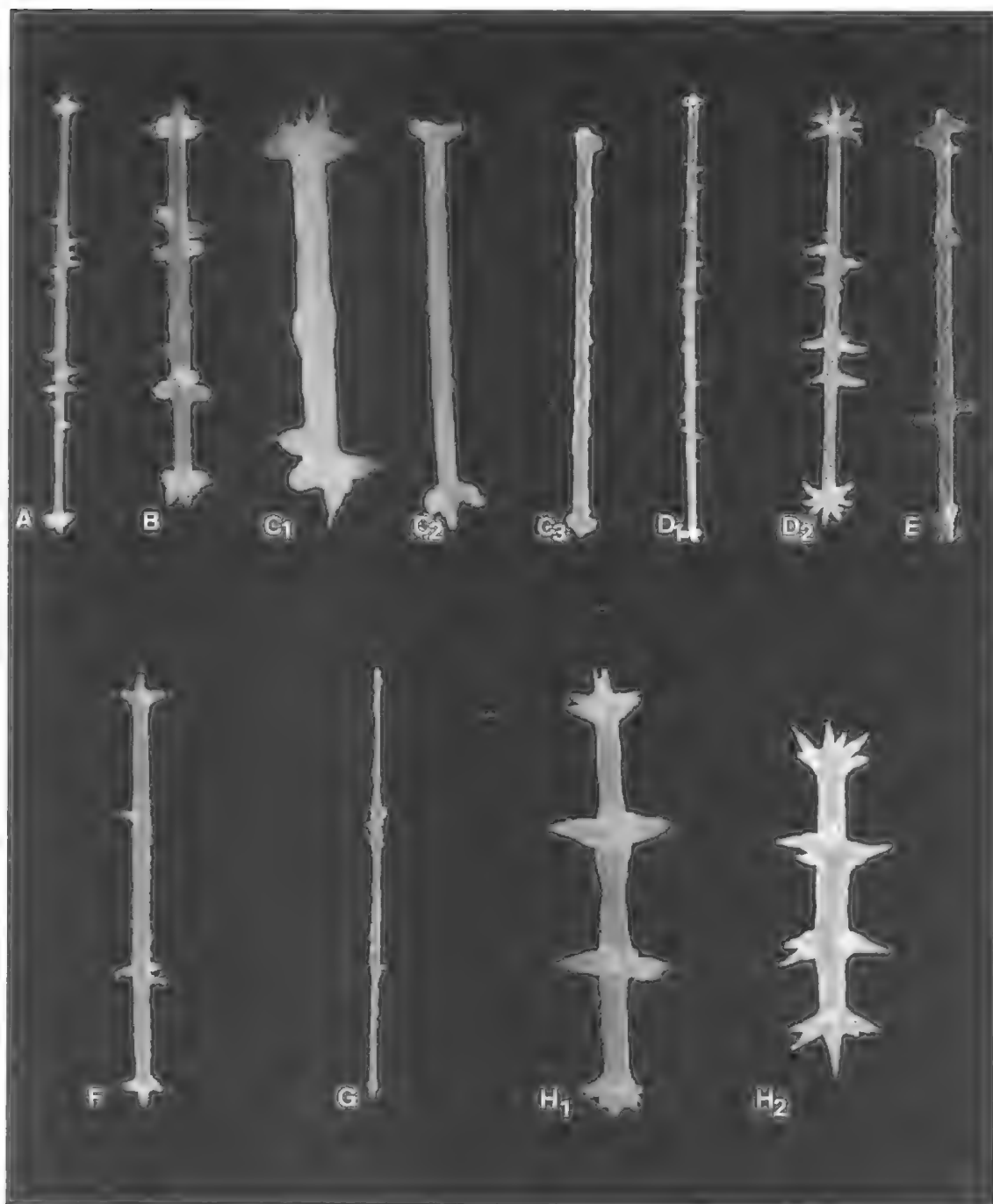


FIG. 7. A-H, Scanning electron micrographs of spinorhabd I microscleres of *Diacarnus* spp. A, *Diacarnus spinipoculum* (Carter), holotype BMNH 1846.10.14.174. Scale: 21.2µm. B, *Diacarnus bellae* sp. nov., BMNH 1994.5.22.11. Scale: 18.5µm. C, *Diacarnus erythraeanus* sp. nov., MNHN DJV52, Red Sea. Scale: C1: 12.6µm; C2, C3: 9.1µm. D, *Diacarnus levii* sp. nov., D1 = holotype QMG305009, D2 = BMNH 1994.5.22.8. Scale: 21.1µm. E, *Diacarnus ardoukoba* sp. nov., holotype QMG305010. Scale: 9.3µm. F, *Diacarnus bismarckensis* sp. nov., holotype QMG305011. Scale: 13µm. G, *Diacarnus tubifera* sp. nov., BMNH 1994.5.22.10. Scale: 15.1µm. H, *Diacarnus megaspinorhabdosa* sp. nov., holotype QMG305013. Scale: H1: 16.2µm; H2: 28µm.

Negombata de Laubenfels*Negombata* de Laubenfels, 1936: 159**TYPE SPECIES***Latrunculia corticata* Carter, 1879: 298 (by subsequent designation, de Laubenfels, 1936: 159)**DIAGNOSIS**

Erect, massive, lobate to elongate, finger-forming, branching. Compressible, with an extremely smooth surface through which large pores are clearly visible. Megasclere skeleton consists of a uniform, elongate, to square-meshed reticulation of clear spongin cored fairly irregularly with thick, slightly curved oxea with strongylote ends, and a clear hollow axial canal. Ectosome, with thin fusiform wavy oxeas in tracts that fan within a thick collagenous ectosome, ultimately forming surface brushes. Microscleres, irregular spinorhabds in two sizes, largest very irregular, thick, without a distinct shaft, smaller, with a distinct straight or curved shaft with spines of uneven length arranged roughly in two central whorls and two terminal bunches, terminal spines commonly double. Immature microscleres, straight rods in which one or more spines from apices are strongly recurved, disposed predominantly on very outside of ectosome, but can also be very dense within choanosome.

Negombata corticata (Carter)
(Figs 2, 6J)

Latrunculia corticata Carter, 1879: 298; Keller, 1889: 401

MATERIAL EXAMINED

HOLOTYPE: *Latrunculia corticata* BMNH 1840.5.6.56-58: "from the Red Sea", three dried fragments from the same specimen (Fig. 2).

DESCRIPTION

Carter (1879) described the sponge as being "erect, solid, lobate...apparently sessile". Type specimen consists of short, ridged, broad fans of different lengths with a restricted base of attachment (Fig. 2). Colour, yellowish white in dry sponge. Surface texture of dry holotype, fibrous, roughened due to shrinkage. Carter (1879) described the fresh sponge as "chondroid" and "smooth as varnish to the unassisted eye" with pores 20 µm diameter and 74 µm apart.

Skeleton. Reconstitution of the dry holotype allowed examination of the skeletal organization

of this sponge. The skeleton consists of a central axis of rectangular meshes formed by spongin fibres, 300-600 µm diameter, not clearly differentiated into primary and secondaries (Fig. 6J). Large oxea are embedded within the fibres, and also occur interstitially. Megasccleres are not arranged uniformly within fibres, but rather, are scattered singly or in groups, and oblique or occasionally perpendicular to fibre axis. An ectosomal skeleton of wavy oxea is present, but this has collapsed in the holotype, rendering the arrangement difficult to determine. Microscleres, densely packed on sponge surface and also in choanosome, almost obscuring choanosomal fibres.

Spicules. Megasccleres. I. Oxeas of main fibroreticulation: thick, straight or slightly curved with rounded strongylote ends, centrally thickened with a distinct hollow axial canal: 346(317-384) × 10-12 µm, n=30; II. Ectosomal oxea: thin, fusiform irregularly curved, wavy, disposed in surface plumose brushes: 422(394-451) × 2.4-6 µm, n=30.

Microscleres. I: Irregular, shaft rarely distinct, overall shape of microscclere straight, curved slightly or spiralled, spines of uneven length arranged roughly in two central whorls and two terminal bunches, terminal spines commonly double: 26(19-31) µm, n=30; maximum width 14-19 µm, shaft width 3-6 µm, n=10; II: Extremely irregular spinorhabds, almost oval when heavily centrally thickened, shaft indistinct and spines unevenly distributed along sides of the spicule: 35(26-43) µm, n=30, maximum width 17-24 µm, shaft width 7-10 µm, n=10.

SUBSTRATE, DEPTH RANGE, ECOLOGY

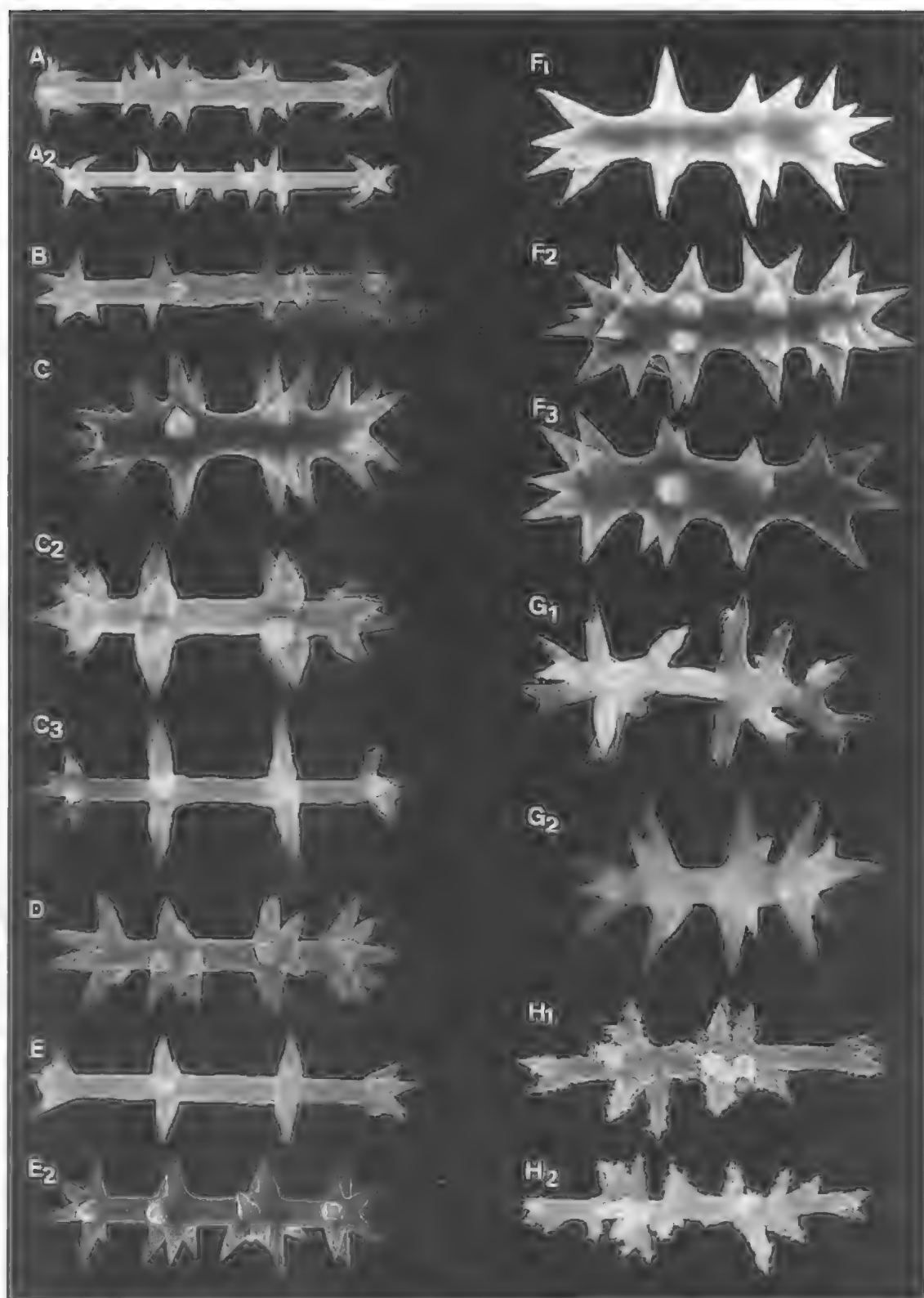
There is no information given in Carter (1879) on the ecology or habitat of this species.

GEOGRAPHIC DISTRIBUTION

Carter (1879) noted that the sponge was supplied by a dealer who stated that the sponge came from the Red Sea.

REMARKS

Examination of a spicule preparation of the holotype of *Latrunculia corticata* Carter (BMNH 1840.5.6.56-58) indicates that this sponge differs considerably from species recognised within *Diacarnus* s.s., *Sigmosceptrella* s.s., or *Latrunculia* s.s. The megasccleres of *Negombata* are two forms of wavy oxea, instead of subtylostrongyles as in *Diacarnus* and styles in *Latrunculia*. Examination of the reconstituted



skeleton of the type specimen reveals megascleres embedded in spongin forming a rectangular mesh from which short ectosomal tracts of thinner, wavy oxeas arise to form plumose brushes within the ectosome. In *Diacarnus* the fibres are clearly differentiated into very large primary fibres, with smaller secondary fibres giving rise to dendritic tertiary fibres in a plumose umbelliform arrangement. Although the microscleres of *Negombata* are also spinulate, they differ from those of other latrunculiid genera. The largest category are so irregular they look like spined lumps of silica, the smaller category are also irregular with dense, frequently double terminal spines that are arranged only vaguely in whorls. The overall spicule is frequently curved or spiralled, with a distinct shaft only rarely visible. The smaller category of spinorhabds derive from straight rods in which one or more spines from the apices are strongly recurved. Carter's illustrations of regular microscleres are thus misleading.

Latrunculia purpurea Carter, from Bass Strait, southern Australia, was also regarded by de Laubenfels (1936) to be a species of *Negombata*. However, *Latrunculia purpurea* appears to be a valid species of *Latrunculia*. Carter (1881) described a "flat, compressed, circular, thin, cake-like or fungiform" sponge, brown-purple in colour, with a "ragged and proliferous upper surface". There is no mention, however, of a "chondroid dermal region" and "fibroreticulate internal structure" described for *Negombata corticata*, rather, the internal structure is "compact and densely spiculous." The microscleres of *Latrunculia purpurea* are typical of *Latrunculia* as the two inner spined discs are disposed towards one end of the spicule, and the microscleres are disposed "to the circumference on the upperside and darker portions, arranged perpendicularly in juxtaposition with the spinous disk of one end outwards (Carter, 1881)." The megascleres, however, are described and illustrated as being oxcote as in *Negombata corticata* and unlike the polytylote or uniform styles of *Latrunculia*. However,

without examination of the type material, it is impossible to speculate further on the affiliations of this specimen.

De Laubenfels (1936) also considered the possibility that *Negombata* was synonymous with *Negombo* Dendy. It is clear from examination of the type species *Negombo tenuistellata* Dendy (BMNH 1907.2.1.28) that this is not the case; the megascleres of *Negombo tenuistellata* are gently curved large styles arranged in vague longitudinal to reticulated tracts within thin hollow-walled tubes, and the microscleres are different, as already shown (see remarks for *Diacarnus spinipoculum*).

***Negombata magnifica* (Keller)
(Figs 3K, 3L, 4C, 6K, 6L, 8G)**

Latrunculia magnifica Keller, 1889: 402

MATERIAL EXAMINED

FRAGMENT OF HOLOTYPE: *Latrunculia magnifica* BMNH 1908.9.24.118 (fragment from the Berlin Museum) from Suakin, Sudan, Red Sea.

ADDITIONAL MATERIAL: MNHN DJV 56: Musha Island, Djibouti, 24m, 11°42.50'N, 43°08.45'E, collected by J. Vacelet, 23 January 1985 (M 3), (fragment deposited as BMNH 1994.5.22.18)

DESCRIPTION

Keller (1889) described the sponge as having many long cylindrical digits arising from a short spreading stalk. A specimen 30cm high, was described as having 25 branches of equal length with a uniform diameter of 6-10mm. Although the digits do not commonly divide to form branches, occasional short stumps or incipient branches are seen. The texture was described as compressible but firm and elastic. The surface of the sponge was completely smooth, slightly shiny, with a translucent surface, and punctured with regularly spaced pores 100-150µm diameter. Oscules were uncommon, tear-shaped and raised slightly on collars. The colour in life was described as deep red-orange which remained in the preserved specimen for a considerable time

FIG. 8. Scanning electron micrographs of spinorhabd II microscleres of *Diacarnus* spp, *Negombata magnifica* (Keller), and acanthose microrhabds of *Negombo tenuistellata* Dendy: A, *Diacarnus spinipoculum* (Carter), holotype BMNH 1846.10.14.174. Scale: A1: 24.2µm; A2: 28.2µm. B, *Diacarnus bellae* sp. nov., BMNH 1994.5.22.11. Scale: 18.2µm. C, *Diacarnus ardonkohae* sp. nov., holotype QMG305010. Scale: C1: 21.3; C2: 16.6µm; C3: 14.6µm. D, *Diacarnus bismarckensis* sp. nov., holotype QMG305011. Scale: 21.3µm. E, *Diacarnus tubifera* sp. nov., BMNH 1994.5.22.10. Scale: E1: 18.2µm; E2: 24.2µm. F, *Diacarnus megaspinorhabdosa* sp. nov., holotype QMG305013. Scale: F1: 34µm; F2: 30.3µm; F3: 34µm. G, *Negombata magnifica* (Keller) MNHN DJV 56. Scale: G1: 9.1µm; G2: 12.5µm. H, *Negombo tenuistellata* Dendy 1905, holotype BMNH 1907.2.1.28, acanthose microrhabd microscleres. Scale: 5.2µm.

before eventually fading. The ectosome was more intensely coloured than the interior of the sponge. Embryos of the parenchymella type were present and large (825-1125µm diameter).

Skeleton. Details of gross morphology, histology, arrangement of the choanosomal skeleton, and spiculation were accurately described and illustrated by Keller (1889). However, for consistency these are re-interpreted here with details of the ectosomal skeleton not evident in the holotype *Negombata corticata*. The skeleton consists of a central axis of thick strongylote oxeas bound into an irregular round-meshed reticulation with abundant stratified spongin. Interstitial megascleres are common. Primary fibres cannot be clearly distinguished from secondary fibres which average 125µm diameter (range: 60-300µm). Keller (1889) notes and illustrates the presence of a "parasitic" algae, thought to be a species of *Calothrix*, living within the spongin fibres. This was not observed in any of our specimens. A distinct ectosomal skeleton is present and consists of regularly and closely spaced compact spicule tracts 30-70µm wide which divide and diverge towards the ectosome where they form fanned brushes (Fig. 6K). Megascleres of the ectosomal skeleton are wavy fusiform oxeas rather than the shorter thicker strongylote oxea embedded in the spongin fibre. The tips of these spicules protrude through the dermal membrane in patches. Microscleres are common within the choanosome and present as a distinct layer in the upper third of the ectosome. The ectosome is distinct, collagenous, approximately 180µm deep (range 240-430µm), and perforated by vertical poral canals 150-200µm wide which lead to subdermal lacunae.

Spicules. Megascleres. I: Oxeas of main fibro-reticulation, thick with hollow central axis, straight or slightly curved, with slightly restricted strongylote ends: 346 (298-385) x 10 (4.8-12)µm, n=30; II: Ectosomal oxea, fusiform irregularly curved, wavy, disposed in surface plumose brushes: 435 (403-490) x 1-3µm, n=30.

Microscleres. I. Slender, straight, curved slightly or spiralled, spines of even length and arranged in two discrete central whorls with terminal bunches, terminal spines commonly double, occasionally recurved, shaft clearly distinguished between spines: 23 (19-26)µm, n=30; maximum width 10-12µm, shaft width 3µm, n=10 (Fig. 3K, 3L); II: Spicule very stout with short scattered irregular spines, spines absent in some parts of the microscelere: 33 (24-

41)µm, n=30; maximum width 22-26µm, shaft width 7-20µm, n=10 (Fig. 8G).

SUBSTRATE, DEPTH RANGE, ECOLOGY

The sponge was abundant on coral reefs and vertical coral walls, and is one of the most prominent sponges in the Gulf of Eilat between depths of 3-30m (Kashman et al., 1980). Very large embryos were abundant in a sponge collected in July of 1985 (Fig. 6L). It is not known whether these are pigmented bright yellow-orange as in *Diacarnus*.

GEOGRAPHIC DISTRIBUTION

Suakin, Sudan, Red Sea; Djibouti, Gulf of Aden (Fig. 4C)

REMARKS

Negombata magnifica is distinct from *N. corticata* in gross morphology, *N. magnifica* forming long, cylindrical, whip-like branches, the later being a clump of broad ridged fans. Histologically, the species are rather similar, but with discernable dimensional and morphological differences between the megascleres and microscleres. The later are extremely dense in the choanosome of *N. corticata*. The spongin skeleton of *N. corticata* is more robust.

DISCUSSION

Diacarnus and *Negombata* are distinct within the Latrunculiidae as they possess a fibro-reticulate skeleton with an unusual umbelliform "ectosomal" skeleton developed to a greater or lesser degree, and a highly collagenous mesohyl matrix structure with tough fibres which superficially resemble vertebrate ligaments in soft tissue. *Diacarnus* is remarkably homogenous with the skeletal arrangement, huge fibres and spicule dimensions of all species being similar. We have emphasised the gross morphology of the sponge, coupled with the presence or absence of a second larger category of microscelere, and the morphology of these spicules, in recognizing new species. The disposition of these microscleres throughout the sponge, and spicule and fibre dimensions are less reliable characters for species differentiation. *Diacarnus spinipoculum* and *D. tubifera* are both vasiiform but the former is barrel-shaped rather than tubular. These two species are further separated on the presence of large spinorhabds in *D. tubifera*, in addition to very abundant dendritic tertiary spicule tracts which arise from well within the choanosome of this species. *Diacarnus*

bellae from Micronesia and *D. levii* from New Caledonia are very similar but are separated on gross morphology and spicule dimensions. The three ramose species *D. erythraeanus*, *D. ardoukobae*, and *D. bismarckensis*, are separated geographically, and the two Red Sea species are further separated by the presence of large spinorhabds in *D. ardoukobae*. *Diacarnus megaspinorhabdosa* has the largest megascleres of all species thus far described, and highly diagnostic spinorhabds.

Although there are many similarities between *Negombata* and *Diacarnus*, there are several major differences which separate them, including the presence of diactinal megascleres and a regular tight-meshed "axial" fibrous skeleton in which the fibres are only lightly cored by megascleres. The skeletal arrangement of *Negombata* superficially resembles that of several myxillid, raspailid and microcionid poecilosclerid genera which emphasise an axial fibroreticulation and ectosomal brush-forming skeleton. In *Diacarnus*, the fibres are packed regularly with spicules with no visible spongin surrounding them. *Negombata corticata* and *N. magnifica* are differentiated primarily on gross morphology, spicule differences, and possibly the development of the ectosomal skeleton.

Sponges previously identified as *Latrunculia magnifica* (Keller) from the Red Sea uniquely contain compounds known as latrunculins (Nee-man et al., 1975; Kashman et al., 1980). With the transfer of this species to *Negombata* here, the latrunculins become a potentially diagnostic chemical marker for sponges of the genus *Negombata*. Several latrunculin-containing voucher specimens from the Philippines and Indonesia supplied by M-K. Harper (Scripps Institute of Oceanography) and the Coral Reef Research Foundation, were examined as this report went to press. While these sponges are clearly related morphologically to the two known species of *Negombata*, there are considerable differences, requiring the examination of further material before a complete identification can be made. Species identified as *Latrunculia brevis* and *L. conulosa* from Australia (in Butler & Capon, 1991; 1993), *Sigmatopora laevis* (Alberici et al., 1982), and *Diacarnus bellae* sp. nov. (F. J. Schmitz, D. J. Faulkner, pers. comm.), contain norsesterterpene peroxides. Confirmation of previous identifications for the specimens whose chemistry is known and has been published, is presently being carried out (Kelly-Borges and Maltern, in prep.).

The possession of large tracts of diverging megascleres, megasclere brushes at the surface, spined acanthomicrorhabds, and large bright yellow larvae, in *Diacarnus* and *Negombata*, is reminiscent of *Sigmatopora* Dendy. Examination of the type species of *Sigmatopora*, *S. quadrilobata* (BMNH 25.11.1.1641), and *Spirastrella* (= *Sigmatopora*) *fibrosa* Dendy (1897), which Dendy (1922) regarded as the 'true' type species of the genus *Sigmatopora*, reveals several characteristics which distinguish *Sigmatopora* from *Diacarnus* and *Negombata*.

The largest microscleres of *Sigmatopora* are very similar to those of *Diacarnus* and *Negombata*; but the spines of the two inner whorls of the rhabd axis are longer than those of the terminal whorls, which are more or less in the same plane as the axis of the spicule, and they are closer to the terminal whorls than they are to each other, imparting a dumbbell appearance to the spicule (Fig. 3D, 3F, G). The spinorhabds of *Diacarnus* and *Negombata* are more regular with spines of equal length in whorls that are separated equidistantly, in most species, along the axis of the spicule (Fig. 3I, J, L). In all specimens of *Sigmatopora* examined, these microscleres are packed in confusion in a dermal crust at the surface (Fig. 9A, B) of the sponge, rather than scattered in a band within a broad collagenous detachable ectosome, as in *Diacarnus* and *Negombata*.

The developmental stages of the spinorhabds of these three genera also differ. The rhabds of *Sigmatopora* are distinctly sigmoid in shape (Fig. 3D, E, G). These were illustrated by Dendy (1905: Plate 18 Figure 4c; Dendy 1921: 122) who regarded these as the major diagnostic character for *Sigmatopora*. These are not to be mistaken for the "true" sigmas which can also be found in the BMNH histological slide of the holotype. There were also small anchorate isochelae and tylostyles in the section and thus the lot is obviously foreign. The earliest protorhabd forms of *Sigmatopora* and *Negombata* are rather more similar to each other than they are to the protorhabds of *Diacarnus*, which are simply spinulate as in the mature spicule (Fig. 3H). The earliest spines of the rhabds of *Negombata* and *Sigmatopora* are strongly recurved spines with kinked tips which eventually become the spines along the shaft. However, where the shaft of *Sigmatopora* becomes sigmoid (Fig. 3B, E) (Dendy, 1921), those of *Negombata* remain straight (Fig. 3K).

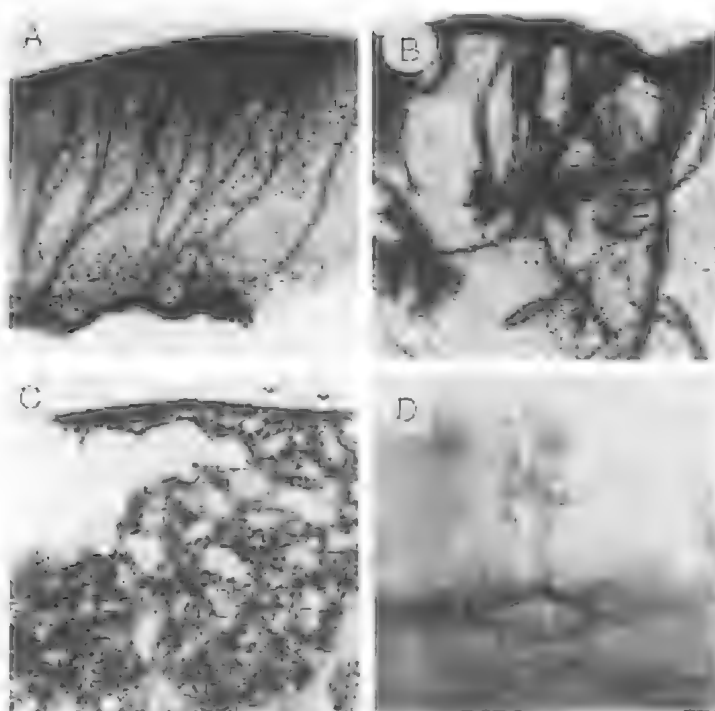


FIG. 9. A-D, Skeletal arrangements of *Sigmosceptrella* and *Latrunculia*. A, *Sigmosceptrella quadrilobata* Dendy, holotype BMNH 25.11.1.1641, Indian Ocean, 30 x. B, *Sigmosceptrella* sp., Q66C-2779, Sisters Reef, Murray Reefs, 3m, Warnbro Sound near Rockingham, Perth, Western Australia, 32° 21.3'S 115° 41.3'E, 30 x. C-D, *Latrunculia* sp., Q66C-2463, Horse-shoe Reef 3km WNW of Margaret Brock Lighthouse, 18m, Cape Jaffa, Kingston, South Australia, 36°56.8'S, 139°35.0'E. C, the skeleton is a whispy reticulation of loose tracts of styles, with a layer of erect discate microrhabds at surface of sponge, 30 x. D, single discorhabd with terminal spines embedded beneath the ectodermal membrane, above a layer of tangential styles, 2000 x.

The megascleres of *Sigmosceptrella* are arranged in plumose tracts which arise from the base of the sponge, branching continuously to form very fine fibres which terminate in brushes at the surface (Fig. 9A,B), unlike the plumoreticulate arrangement of huge compact spongin-bound fibres with apical umbells, as in *Diacarnus*. The fibres of *Diacarnus* are clearly visible to the unaided eye, and are separable from the mesohyl matrix, resembling ligaments. There is also no continuous dermal palisade of megascleres at the surface of *Sigmosceptrella*.

The family Latrunculiidae has an unstable history and has been switched between the orders Hadromerida (e.g., Topsent, 1922; Dendy, 1922; Bergquist, 1978), and Poccilosclerida (e.g. Lévi, 1973; Van Soest, 1984, see Hooper, 1986). As it is currently perceived, the family is heterogeneous, sharing features that belong to both orders.

Diacarnus, *Negombata* and *Sigmosceptrella* incubate huge parenchymella larva, and embryos 500µm of diameter have been found in a Mediterranean species of *Latrunculia* (Vacelet, 1969), while all known hadromerid sponges are oviparous. However, in contrast to the obvious affinity of these genera with poccilosclerid sponges which incubate larvae, *Diacarnus* and *Negombata*, in particular, are similar to many hadromerid genera such as *Tethya*, *Spirastrella* and *Polymastla*, which emphasise heavily collagenous tissue, particularly in the cortex.

Although there is no clear resolution of the affinities of these genera with other demosponges, several patterns have emerged from this study of morphological characters. It is quite clear that *Diacarnus*, *Negombata* and *Sigmosceptrella* are more closely related to each other than they are to *Latrunculia*, type species of the family Latrunculiidae. The skeletons of these three genera, including another latrunculiid *Podospongia*, are in complete contrast to that of *Latrunculia*, all genera emphasising a complex plumose fibro-reticulation, while the skeleton of *Latrunculia* s.s. is a wispy reticulation of very loose

tracts of styles with a tangential surface layer of megascleres (Fig. 9C). Although the morphology of the acanthomicrorhabd microscleres in *Sigmosceptrella*, *Diacarnus*, and *Negombata* approach those of *Latrunculia* in general form, the microscleres of the latter are discate rather than spinulate. The microscleres of *Latrunculia* s.s. are arranged in a peculiar erect palisade of microscleres with their terminal disc embedded beneath the ectosomal membrane, the remainder of the microscleere free of tissue outside the sponge (Fig. 9C, D). In *Sigmosceptrella* and *Negombata*, microscleres are densely packed in the outer cortex, while in *Diacarnus* these are less dense and contained in a band mid-cortical band.

Morphological data suggest that *Latrunculia* s.s., and possibly *Barbozia* with its palmate isochelae, may be more closely related to

iophonid poecilosclerids such as *Zyzzya*, as they share several features such as a tangential surface layer of megascleres, erect surface spicules (although in *Zyzzya* these spicules are tangential tyloles or strongyles, and acanthoxeas, respectively), deep brown or green colouration, and in the possession of fistules. It seems likely from morphological data, also, that *Diacarnus*, *Negombata*, *Sigmosceptrella*, and *Podospongia*, should not be included in the family Latrunculiidae. Although it is clear that these genera are similar in some respects to some hadromerids (collagenous tissue, radial symmetry in *Podospongia*, etc.), the vast majority of characters are shared with poecilosclerids (plumose-reticulate fibre skeleton, chemistry, reproduction), suggesting that this group also constitutes a poecilosclerid family, but separate from the Latrunculiidae, rather than a hadromerid family. However, as there is no clear resolution of this hypothesis we retain them as *incertae sedis* within the Family Latrunculiidae until further data is available. Secondary metabolite data and DNA sequence data acquisition and analysis are currently in progress towards this end (Kelly-Borges, unpublished data).

Diacarnus is predominantly a shallow-water genus with a broad latitudinal distribution within tropical West Central Pacific marine environments (Fig. 4). *Diacarnus spinipoculum* is very widely and sparsely distributed in temperate south-eastern Australia and tropical Micronesia and Fiji. The longitudinal distribution is however, remarkably disjunct, as two species of *Diacarnus* also occur in the Red Sea (*D. erythraeanus* and *D. ardoukoba*) with the two known species of *Negombata*. Except in the Red Sea and Gulf of Aden, *Diacarnus* has not been recorded further west than the Philippines despite extensive recent sampling within the broad Indo-Pacific region.

This disjunct Red Sea-Indo-Pacific distribution has been indicated for several Indo-Pacific species of sponge, including well known species such as *Psammaphysilla purpurea*, *Hyrtios erecta*, *Dysidea herbacea*, *Phyllospongia papyracea*, and *Theonella swinhoei*. Sixty percent of the Red Sea records in Lévi (1958) were of species known previously only in the Indo-Pacific. A number of Red Sea coral reef fishes show a similar level of differentiation from related species found in the Indo-West Pacific (Allen, 1979; Steene, 1977). Histological examination of the obviously very closely related sister-species groups which contain *D. erythraeanus* in the Red Sea, and *D. levii* in New Caledonia, and *D.*

ardoukoba in the Red Sea and *D. himarckensis* in the Indo-Pacific, reveal small but consistent differences through geographic separation. It is likely that subtle differences will also be found for the species indicated in earlier literature to have a Red Sea / Indo-Pacific distribution, especially those genera which have few reliable characters to used in species separation such as *Psammaphysilla*, *Dysidea*, and *Hyrtios*. It is becoming increasingly obvious that species previously thought to be "cosmopolitan" actually consist of cryptic sibling species (Bergquist & Kelly-Borges 1991; Hooper et al., 1992; Kelly-Borges & Bergquist, 1994; Solé-Cava et al., 1991).

KEY TO SPECIES OF *DIACARNUS*

- 1a. Large tubular or spherical sponge with deep wide apical atrium 2
- 1b. Massive subspherical or digitate sponges, solitary or coalescent 3
- 1c. Irregular sprawling branches 4
- 2a. Tube or vase-shaped sponge, up to 80cm long and 30cm wide, 8-15cm apical atrium, surface with lobate projections, extremely abundant dendritic ectosomal fibres and large irregular spinorhabds, found in Micronesia, common in the Bismarck Sea from Madang to Kavieng, New Ireland, and rarely in southern Papua New Guinea *Diacarnus tubifera* sp. nov.
- 2b. Barrel-shaped sponge, up to 50cm high and 40cm diameter, deep, wide, apical atrium, slender megascleres and only very thin microscleres of the smallest category that can be easily overlooked, found in Micronesia, Fiji, and in south Australia *Diacarnus spinipoculum* sp. nov.
- 3a. Spherical sponge, 6-8cm diameter, frequently joined to adjacent sponges to form a small clump, oscules white-rimmed and arranged apically in a cluster or serially, slender megascleres and thin microscleres that can be easily overlooked, only recorded from Micronesia so far *Diacarnus bellae* sp. nov.
- 3b. Thick erect digits or lobes, 3-4.5cm in diameter, anastomosing to form a large sprawling mass, oscules on ends of digits, slender megascleres and only very thin microscleres of the smallest category that can be easily overlooked, found in New Caledonia and rarely on the central Great Barrier Reef *Diacarnus levii* sp. nov.
- 3c. Thickly encrusting to lobate, huge spinorhabds present. Wide, sparse distribution - found in southern Papua New Guinea, Philippines and Madang coast of Papua New Guinea *Diacarnus megaspinorhabdosa* sp. nov.
- 4a. Large regular spinorhabds present, found on Madang coast, and west coast of New Ireland,

- Papua New Guinea
 *Diacarnus bismarckensis* sp. nov.
 4b. Found in Red Sea 5
 5a. Large spinorhabds present
 *Diacarnus ardoukoba* sp. nov.
 5b. Large spinorhabds absent
 *Diacarnus erythraeanus* sp. nov.

ACKNOWLEDGEMENTS

We thank personnel of CRRF, Micronesia, AIMS, Townsville, and ORSTOM, New Caledonia, for collection of samples, and the personnel of Motupore Island Research Department, University of Papua New Guinea, for field and laboratory support whilst in Papua New Guinea. We thank Clive Wilkinson for specimens from the Red Sea, and Mary Kay Harper, SIO, La Jolla, for providing a specimen from Pohnpei Island, Micronesia. The specimens from Djibouti were collected during the expedition "Ardoukoba" and those from Djeddah were collected during a trip organized by the Faculty of Marine Sciences in Djeddah. We thank Klaus Kelly-Borges (preparation of material for histological examination, and translation of Keller (1889) from German to English), Clare Valentine (location of specimens), Peter York and Phil Crabb (micro and macro photography), all of the NHM, London. We thank CRRF, Micronesia, for underwater photography of Micronesian, Papua New Guinean, Fiji and Philippine specimens of *Diacarnus*, and Chantal Bézac and Isabelle Mahieu, for their help with SEM microphotography. Thanks to Professor Ralph-Heiko Mattern for discussions on the chemistry of these sponges. This is Harbor Branch Oceanographic Institution Contribution No. 1090.

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OBSERVATIONS OF THE AMETHYST PYTHON (*MORELIA AMETHYSTINA*) FEEDING ON RAINBOW BEE-EATERS (*MEROPE ORNATUS*). *Memoirs of the Queensland Museum* 38(2), 504, 1995:- Observations on feeding by arboreal snakes are poorly documented. Members of *Morelia* are primarily nocturnal, rock inhabiting and/or arboreal snakes that commonly bask during daylight hours. Amethyst pythons (*Morelia amethystina*) eat a wide variety of vertebrates (Cogger, 1992), including birds and mammals (Wilson & Knowles, 1988).

Amethyst pythons were observed eating rainbow bee-eaters (*Merope ornatus*; length 230-280mm (Lowe, 1989) measured as the distance from the tip of the bill to the tip of the tail, rounded to the nearest 5mm, and where a bill or tail is unusually long, as with the rainbow bee-eater, its form is included in the length) on Milman Island (11°10.3'S, 143°00.8'E; Great Barrier Reef Marine Park Code 11-007), a vegetated sand cay located approximately 112km southeast from Thursday Island, Torres Strait and 45km northeast from Orford Ness, Queensland, Australia.

All feeding observations took place between 0600h and 0900h on 19 March and 21 March, 1994. Up to four pythons had been observed simultaneously stretched out on the defoliated branches of *Premna serratifolia*, first on 10 March, and then 18-23 March. The snakes appeared camouflaged, their bodies curving so they blended with branches of the shrub.

The first observation was of an adult rainbow bee-eater (extended central tail feathers) within the coils of a python at 0645h on 19 March. The python moved approximately 2 m down the branch before swallowing the bird. This sequence took approximately 25 minutes. Then the snake moved back to the top of the branch. Another rainbow bee-eater landed on the branch above the snake, but flew off as the python moved towards it. The snake retreated down the branch (approximately 2m) and curled up in a fork in the shrub. The following day (20 March) the snake did not appear to move. On 21 March, at 0815h the same python caught a juvenile rainbow bee-eater (central tail feathers not extended). The snake swallowed this bird in 5.5 minutes. The snake was the same one observed on 19 March, because the bulge made from eating the first bird was still visible, and the snake was on the same branch. After swallowing the juvenile bird, the snake slithered back up the branch and waited for 40 minutes, apparently trying to catch another bird. Even though other rainbow bee-eaters were flying around its head, the python did not catch any. Rainbow bee-eaters catch their prey (flying insects) by "hawking", returning to perch and batter their prey before ingesting it (MacDonald, 1973). This method would bring the birds into contact with hunting snakes. White-breasted woodswallows (*Artamus leucorhynchus*; length 170-180mm), yellow-bellied sunbirds (*Nectarinia jugularis*; length 110-115mm), and a spangled drongo (*Circus bracteatus*; length 280-320mm) (Lowe, 1989) all landed nearby. These may also be preyed upon. The white-breasted woodswallow appeared to swoop at/near the snake in alarm.

Although the snake was not caught and measured, the size of the python (1.25-1.50m in total length) observed feeding on the rainbow bee-eaters appeared to be in the smaller range for records on Milman Island. Six females measured had a total length ranging from 124.5-261.0cm and three unsexed pythons measured had a total length ranging from 60.0-220.0cm.

Rainbow bee-eaters are a migratory species in the western South Pacific Ocean area. They move from their southern breeding areas in Australia to over-winter in Torres Strait and Papua New Guinea (Blakers et al., 1984). Although the distribution of rainbow bee-eaters is dependent on the abundance

TABLE 1. Summary of Amethyst Python (*Morelia amethystina*) measurements collected from snakes caught on Milman Island, northern Great Barrier Reef, Queensland, Australia. Sex was determined by examination of spur size and attempted eversion of hemipenis. ? = Sex was not determined. Abbreviations: HL=Head length, SVL=Snout length, VTL=Vent to tail length, TL=Total length. All measurements are in centimetres.

Date	HL	SVL	VTL	TL	Sex
5 Feb 1992				60.0	?
8 Feb 1992		145.0	28.0	173.0	?
10 Feb 1992		223.0	38.0	261.0	Female
12 Feb 1992		150.0	31.0	181.0	Female
19 Feb 1992		185.0	35.0	220.0	?
7 Mar 1994	5.5	184.5	35.5	220.0	Female
10 Mar 1994	3.8	103.8	20.7	124.5	Female
17 Jan 1995		149.0	26.0	175.0	Female
19 Jan 1995		111.5	22.5	134.0	Female

of insects (Blakers et al., 1984), it is not known how long the rainbow bee-eaters stay at Milman Island. The island supports a seasonal nesting colony of Torres Imperial Pigeons (*Ducula bicolor*; length 380-440mm) (King, 1990), as well as numerous pairs of yellow-bellied sunbirds. All of the birds mentioned are small enough to be possible food sources for the snakes, although consumption of these other species has not been observed. When rainbow bee-eaters are not present on Milman Island, the pythons must prey on other species. Because there are no mammals on Milman Island, considered a common prey for amethyst pythons (Cogger, 1992), the pythons are probably feeding on other birds, including ground nesting species, found on the island.

Acknowledgements

The U. S. Army Corps of Engineers provided a grant to Dr. André M. Landry Jr. of Texas A&M University - Galveston which assisted K.A.L. with research on the island.

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OBSERVATIONS OF HUMPBAC WHALES (*MEGAPTERA NOVAEANGLIAE*) ON A CRUISE TO NEW CALEDONIA AND THE CHESTERFIELD REEFS

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Gill, P.C., Eyre, E.J., Garrigue, C. & Dawbin, W.H. 1995 12 01: Observations of humpback whales (*Megaptera novaeangliae*) on a cruise to New Caledonia and the Chesterfield Reefs. *Memoirs of the Queensland Museum* 38(2):505-511. Brisbane, ISSN 0079-8835.

During a yacht-based survey in the austral winter of 1992, low numbers of humpback whales were observed around the main island of New Caledonia, and humpback song was recorded there. The song, the first recorded in New Caledonian waters, showed similarities to song recorded off eastern Australia. No humpback whales were detected at Chesterfield Reefs in the eastern Coral Sea, despite their possible status as a breeding area. Only a small portion of the Chesterfield Plateau was surveyed. Reports of sightings there in recent years indicate at least occasional visitation by humpback whales.

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Group V humpback whales feed in Antarctic Area V (130°E-170°W) during the austral summer and segregate into tropical breeding areas in the southwest Pacific during winter (Dawbin, 1966). Catch data of 19th century American pelagic whalers indicated wintering, and presumably breeding, concentrations around Tonga, Fiji, and the Chesterfield Reefs in the Coral Sea (Townsend, 1935). French whalers killed humpbacks in the Loyalty Islands of New Caledonia, as well as at the Chesterfield Reefs (du Pasquier, 1982). Many American whalers also visited parts of New Caledonian waters during the 19th century (Langdon, 1984). Humpbacks were marked by Dawbin using "Discovery" tags around Vanuatu and the Loyalty Islands during the late 1950s, but no marks were recovered (Dawbin, 1964). Recent incidental sightings data, unreported at the outset of this study, indicate that humpback whales, including newborn calves, are now frequently seen in New Caledonian waters during winter and spring (Garrigue and Gill, 1994). There has been speculation, based on Townsend's (1935) charts, as to whether Chesterfield Reefs are still a humpback breeding destination (Dawbin and Falla, 1949; Paterson, 1991).

This paper describes a yacht-based cruise during the austral winter of 1992, initially to investigate whether humpback whales migrate to New Caledonia and the Chesterfield Reefs. While in New Caledonian waters the study focused on humpback song, never recorded in the region, for comparison with other areas.

METHODS

The 15-metre cutter "Iniquity" was equipped with GPS navigation, depth sounder (max. depth 100m), radar, weatherfax, wind instruments and seawater thermometer. With a minimum of 2 observers, continuous visual monitoring was carried out (except when interrupted by sailing duties) from deck 2-3m above sea level (distance to horizon 5.6-6.7km) while the vessel was making way. In sheltered lagoon waters where whales were more likely to be encountered, when the vessel's motion allowed, an observer was positioned up the mast 12m a.s.l. (distance to horizon 13.5km).

"Iniquity" departed Coffs Harbour, New South Wales on 7 July 1992, and sailed northeast to Noumea. Nearly 4 weeks were spent in New Caledonian waters from 14 July, and the passage westward across the Coral Sea to Queensland took place during 11-31 August (Fig. 1). This timing allowed the vessel to be in these areas around the estimated peak of the east Australian humpback breeding season (Simmons and Marsh, 1986; Paterson, 1991).

Humpback song may be detected over tens of kilometres (Cato, 1991), a much greater range than visual observation permits. It is commonly heard in breeding areas and on coastal migration routes, even in darkness. On a previous yacht-based study in Australian waters, humpbacks were detected 3 times more often by song than by sight (Dawbin and Gill, 1991). For these reasons

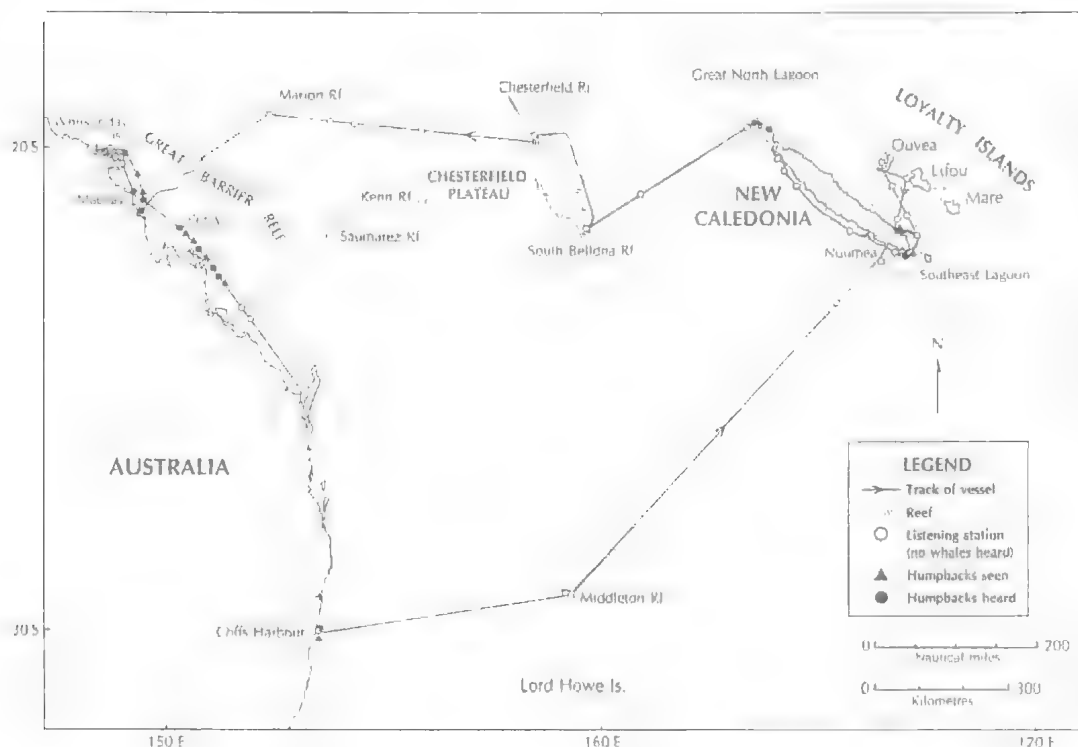


FIG. 1. Map showing the route taken by the vessel, locations of humpback whale sightings, and listening stations.

acoustic monitoring was regarded as the primary detection method for this study.

Hydrophone soundings were taken for about 10 min every 3-4 hours while at sea (approximately every 30km) when conditions allowed, in order to ensure that the same animals were not detected at more than one listening station. Soundings were taken not only near coastlines, islands and reefs, but also distant from land, in order to ascertain possible migration routes (Clapham & Mattila, 1990). Monitoring was also conducted when whales were sighted. A minimum of 20 min was recorded whenever possible, to ensure covering at least 1 full song cycle. Acoustic equipment consisted of an Edmund Scientific 41759 hydrophone, connected via a 40dB preamplifier with high pass filter to a Sony WMD6-C cassette recorder. System response was 30 Hz-6 kHz.

Song from New Caledonia was compared with song from Eden (southbound migration, 1991) and Coffs Harbour (northbound migration, 1992), New South Wales (Table 2). Song analysis was both aural and spectrographic. Cato (1991) has noted that humpback whale sounds are well suited to human aural perception. Songs are com-

posed of units, phrases and themes (Cato, 1991). For this comparison, units were denoted by subjective descriptive terms (e.g., "yap", "moan") in the order in which they occur (Table 4). Phrases were used as the measure of aural comparison. Sonograms of selected segments of song were made with a Kay Elemetrics DSP Sono-Graph model 5500-1 (Fig. 2). Analysis filter bandwidth was 15 Hz.

RESULTS

DETECTION OF WHALES

No humpback whales were detected at Ouvéa and Lifou in the Loyalty Islands, although only

TABLE 1. Humpback whales sighted, New Caledonia

Date	Position	Locality	Number
19 Jul 1992	22°24'S 166°52'E	Southeast Lagoon	2
27 Jul 1992	21°57'S 166°51'E	east coast	1
2 Aug 1992	22°25'S 166°55'E	Southeast Lagoon	2

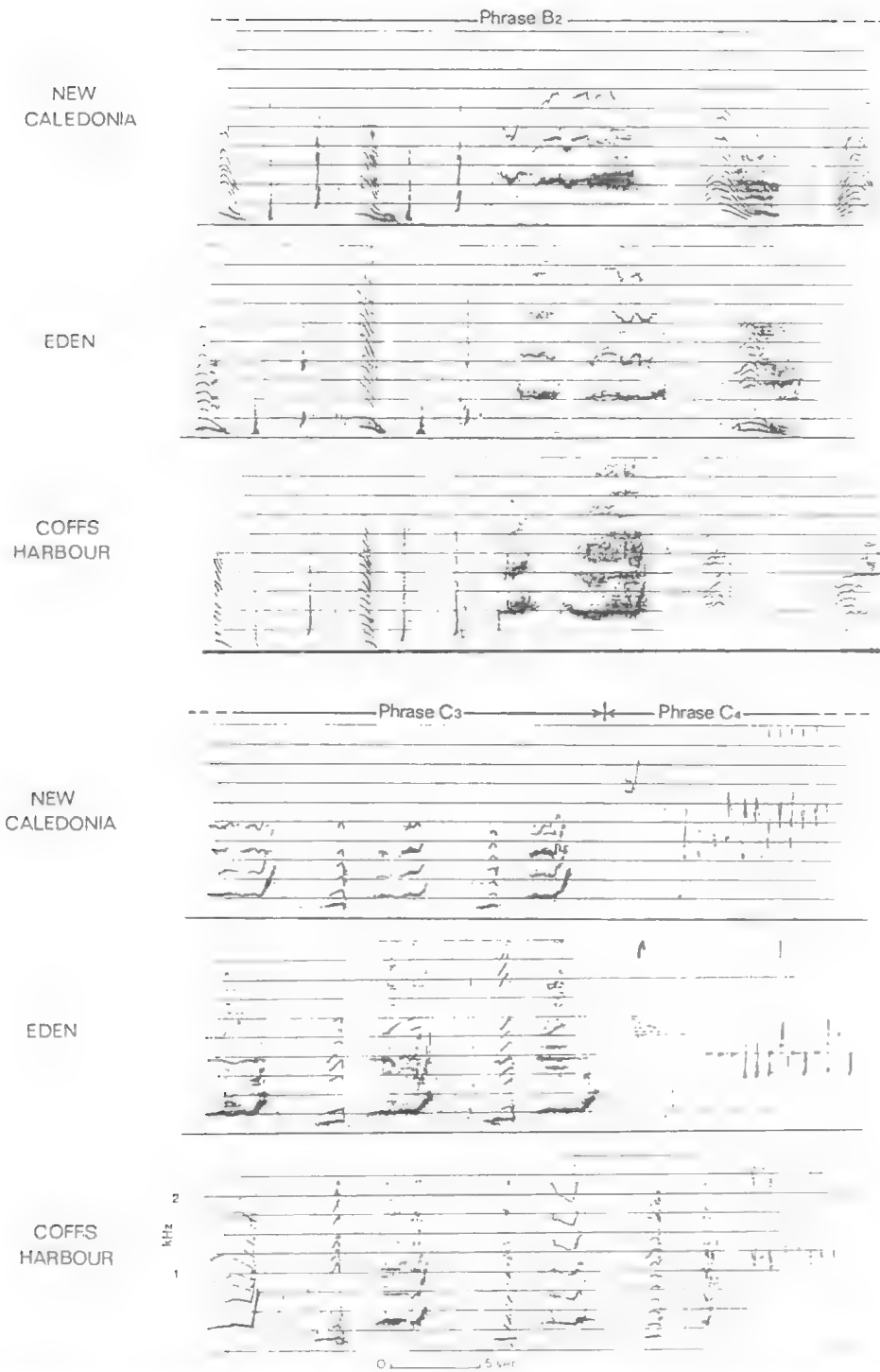


FIG. 2. Sonograms showing comparison of segments of song phrases from New Caledonia and two locations on the east coast of Australia. Samples shown are not consecutive.

TABLE 2. Locations of humpback song heard, number of whales singing, and duration of recordings.

Date	Position	Locality	Singing	Duration
17 Nov 91	37°00'S 150°00'E	Australia: Eden	1	90 min
06 Jul 92	30°18'S 153°09'E	Coffs Harbour	1	90 min
2 Aug 92	22°25'S 166°55'E	New Caledonia: Southeast Lagoon (Cap Ndoua)	1	107 min
16 Aug 92	19°44'S 163°55'E	Great Northern Lagoon	1	19 min
16 Aug 92	19°36'S 163°35'E	Great North Lagoon (I. Belep)	1	15 min
18 Aug 92	19°30'S 163°33'E	Great North Lagoon (I. Belep)	1	60 min

small areas around these islands were examined due to strong winds. Five humpbacks in 3 pods were sighted in the east and southeast of the main island of New Caledonia during 463 km travelled in lagoon waters (Fig. 1; Table 1). These sightings have been included in the incidental sightings study of Garrigue and Gill (1994). Wind strengths exceeded 30 kmh⁻¹ for more than half of the period spent in New Caledonian waters, making both visual and acoustic detection of whales difficult at these times.

Song was detected and recorded on four occasions in New Caledonian waters, off both south-east and northwest extremities of the main island (Table 2). Song was heard during only one of three sightings due to wind-induced water noise during the other two. Humpbacks were detected in the Great North Lagoon of New Caledonia by sound alone; visual monitoring in good to excellent conditions detected no whales.

No humpback whales were detected during a 22-hr visit to South Bellona Reef (21°53'S, 159°28'E) at the southern end of Chesterfield Plateau in calm clear conditions on 20-21 August. The vessel was anchored during this period, and visual and acoustic observations were made at 2-hourly intervals. No humpback whales were detected in the Chesterfield Reefs lagoon (19°55'S, 158°25'E) during 22-26 August, despite reasonable to excellent conditions. Though the vessel traversed the lagoon twice, it was anchored most of the time. The entire lagoon was visible, and was scanned several times per day from the vessel's mast, while at anchor. A hydrophone was continuously deployed, and was mon-

itored for 10 min every 2 hour except during periods of sleep.

No humpback whales were detected in open ocean waters, or during visits to Middleton and Marion Reefs in the Coral Sea (Fig. 1). After entering the Great Barrier Reef at 20°15'S on 31 August, humpback song was frequently heard between 20°04'S, 149°05'E and 22°54'S, 151°05'E, where monitoring was discontinued on 20 September. At times up to 4 whales could be heard singing simultaneously, and several humpbacks were seen, including 4 cow-calf pairs. A notable exception was within the Whitsunday Islands, where heavy vessel traffic was evident, and no whales were seen or heard.

SONG ANALYSIS

Songs from the three areas compared here (New Caledonia Southeast Lagoon, Eden, Coffs Harbour) each have three themes, and show a high degree of shared phrases, as determined by aural comparison (Table 3). Coffs Harbour shared 89% of phrases with both Eden and New Caledonia, while Eden and New Caledonia shared 78% of phrases. A transcript of the aural comparison is shown in Table 4.

Spectrographic analysis of selected phrases (B2, C3, C4) shows similarities in structure and pattern of humpback sound types from the three areas (Fig. 2).

DISCUSSION

New Caledonia. Useful information was obtained from acoustic monitoring during this study. Song was heard on four occasions, and humpback whales sighted on three. Acoustic monitoring extended the known distribution of humpbacks into the Great North Lagoon, a large

TABLE 3. Shared and unique song phrases.

Phrase	Eden	Coffs Harbour	New Caledonia
A1	X	X	X
2	X	X	X
B1	X	X	
2	X	X	X
3	X	X	X
C1	X	X	X
2	X	X	X
3	X	X	X
4	X		
4A		X	X

TABLE 4. Aural comparison of humpback song, using subjective descriptive terms. Symbols: (R) repeated; (P) pause; ↑ upward; (2) unit repeated, Unit in bracket repeated.

Theme	Phrase	Descriptive terms for units
A	1 2	gloop-low moan-gloop(2)-low moan(2)-cries-cows Payne cries-shorter cries into chirps
B	1 2 3	[gloop-woo cry (P) woo cry-woo cry (P)-lower cries into whistles] - (R) [↑ moan-woo cry (P) woo cry (P) woo cry-lower cries into whistles] - (R) ↑ moan-woo cry (P) woo cry - ↑ moan-long moan-raspy whistle chirps
C	1 2 3 4	↑ moan(2)-long low moan - ↑ moan-long low moan [very short moan-undulating medium groan] - (R) [very short moan-ratchet moans] - (R) yaps
Song characteristics: • dominant (most frequent) theme is B • phrase B2 repeated most often • medium-length song		
b) Coffs Harbour, 6 July 1992		
A	1 2	[gloop-low moan-gloop (2) - low moan-gloop (2) - cries-cows] - (R) [Payne cries-shorter cries into chirps] (R)
B	1 2 3	[gloop-woo cry (P) woo cry (P) woo cry-lower cries into whistles] - (R) [↑ moan-woo cry (P) woo cry (2) - ↑ moan-woo cry-lower cries into whistles] - (R) ↑ moan-woo cry (P) woo cry - ↑ moan-long moan (P) long moan - raspy whistle chirps
C	1 2 3 4A	↑ moan (2)- long low moan - ↑ moan-long low moan [very short moan-undulating medium moan] - (R) [very short moan-ratchet moans] - (R) upward whistle-yaps
Song characteristics • short song; dominant theme probably A • themes quite short • B2 has extra cry since Eden		
c) New Caledonia, 2 August 1992		
A	1 2	[gloop-low moan-gloop (2)-low moan-gloop (2)-cries-cows] - (R) [Payne cries-shorter cries into chirps] - (R)
B	2 3	[↑ moan-woo cry (P) woo cry (2) - ↑ moan-woo cry-lower cries into whistles] - (R) ↑ moan-woo cry (P) woo cry - ↑ moan-long moan raspy whistle chirps
C	1 2 3 4	↑ moan-long low moan- ↑ moan-long low moan [very short moan-undulating medium moan] - (R) [very short moan-ratchet moans] - R upward whistle - yaps
Song characteristics • short song; dominant theme probably A • some units no longer repeated e.g. moan of C1, long moan of B2 • B1 of previous songs no longer present		

and rarely-visited area where no sightings had been reported. It also permitted the first song comparison that we know of between songs from two Group V breeding areas.

Although song was recorded after the vessel entered north Queensland waters, it is not used here for comparison with New Caledonian song. The songs from Eden and Coffs Harbour were most similar in pattern to New Caledonian song, while the north Queensland song had evolved substantially since July 1992. Change of song with time may be complex even along a single migration path (Cato, 1991), let alone between breeding areas as well as seasons. Here we attempt only to report similarities between songs from New Caledonia and east Australia, and these

similarities are most apparent in the examples we have used.

Humpback song is considered to be an indicator of stock identity (Payne & Guinee, 1983); songs tend to show decreased similarity with increased geographical separation within ocean basins, and little or no similarity between ocean basins (Winn et al. 1981; Helweg et al., 1990; Dawbin & Eyre, 1991). While some differences were found between the songs compared here (such as the number of repetitions, or the omissions of units or phrases), such variation can occur between individuals in the same area, or even between different song renditions by an individual (Dawbin & Eyre, 1991). But the song from the three areas was basically similar. The Coffs Harbour song

shared as many phrases with New Caledonia as with Eden (Table 3), while the closest resemblances in spectrographic structure appear to be between New Caledonia and Eden (Fig. 2).

Given the relatively close proximity of New Caledonia and east Australia, and that Group V breeding grounds extend at least to Fiji (Dawbin, 1966) and probably Tonga, the similarities in song reported here are not surprising. An anticipated migratory connection between New Caledonia and other Group V breeding grounds was established in 1993 by a photo-identification match with Hervey Bay, Queensland (Garrigue & Gill, 1994). The similarities in song reported here add further evidence for migratory exchange between humpback whale sub-populations of New Caledonia and east Australia.

Chesterfield Reefs. There are numerous reefs on the Chesterfield Plateau. Townsend's (1935) chart shows a wide spread of points representing humpbacks killed by American whalers between July and October (approximately 45% of them in August), centred around Chesterfield Reefs, toward the northern end of the Plateau. French pelagic whalers operated there at least in 1862 and 1864 (du Pasquier, 1982). The Chesterfield Reefs lagoon is the most sheltered body of water on the Plateau, enclosing roughly 85 sq km. It meets the criteria cited by Whitehead & Moore (1982) as humpback breeding habitat, offering shelter, having suitable depths (average 50m) and warm water (23°C in August 1992). It would have provided whaling vessels with safe anchorage and easy access to whales in or near the lagoon. Numerous whale bones, some of them with marks from chopping implements still visible, have been located by divers in the lagoon (B. Crouch, pers. comm.).

Only two reliable reports have been obtained of humpbacks at Chesterfield Reefs during this century. In June-July 1972, 5-10 humpbacks were seen, and song heard by divers, inside the Chesterfield Reefs lagoon (R. & V. Taylor, pers. comm.). More recently, a humpback mother and calf were observed in the same lagoon over several weeks during September-October 1990 (B. Crouch, pers. comm.) This observer has not seen humpbacks during other frequent visits to Chesterfield Reefs in recent winters. Several French Government (ORSTOM) scientific expeditions during the past decade, including bathymetric surveys of the Plateau itself, have reported no sightings in winter and spring months (B. Richer de Forges, pers. comm.).

Due to bad weather the vessel did not traverse the main body of Chesterfield Plateau during this cruise, visiting only South Bellona and Chesterfield Reefs, for 22 hours and 5 days, respectively. During these periods no whales were observed or heard in good to ideal monitoring conditions. These observations are inconclusive, however, as whales may have been present elsewhere on the Plateau, or at Chesterfield Reefs earlier or later than the yacht's visit. The determination of the current status of Chesterfield Plateau's reefs as a humpback breeding area therefore awaits a more comprehensive study.

ACKNOWLEDGEMENTS

Field assistance from Tim Edkins, Diana Davidson, Peter Drew, Chook Wall-Smith, and Debbie Milham made the study possible. Ken Schultz and Dr Doug Cato assisted with sonograms. Dr Peter Corkeron offered useful comments on the text. Ms B. Jantulik prepared Figure 1. The study was partly funded by a grant from the W.V. Scott Estate, and was conducted under Whale Protection Act Permit No. P1992/027, issued by the Australian National Parks and Wildlife Service, Canberra.

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PREDATION ON THE CANE TOAD (*BUFO MARINUS*) BY THE BLACK KITE (*MILVUS MIGRANS*). *Memoirs of the Queensland Museum* 38(2):512. 1995:- Since the introduction of the Cane Toad into Australia in 1935 there have been several reports of native fauna that have been adversely affected by preying upon them (Covacevich & Archer, 1975; Covacevich & Couper 1992) however several native animals [Water Rats (*Hydromys chrysogaster*), Crows (*Corvus* spp.), Koels (*Eudynamis scolopacea*) and Keelback Snakes (*Tropidonophis mairii*)] are known to prey successfully on them with no obvious toxic effect (Covacevich & Archer, 1975; Covacevich & Ingram, 1990). Herein we report predation upon Cane Toads by nesting Black Kites in July 1995.

During surveys of the Ross River Dam area AJ observed several Black Kite nests with toad remains on the ground below them. Detailed observations were made on a single Black Kite nest in a paperbark tree (*Melaleuca nervosa*) beside a farm dam approximately 24km South West of Townsville, north-east Queensland (Map No. 8259 Grid Ref. 715 480). While there were no young in the nest, six Black Kites were perched around the nest and in adjacent trees.

Over twenty toad remains were observed lying on the ground below the nest. Furthermore, there were toad remains hanging from branches beside the nest suggesting that the Black Kites had fed portions of Cane Toad to the young in the nest. Close inspection of the toads revealed that they had had portions of their internal organs removed. The toads appeared to have been opened from the ventral surface presumably allowing the Kites to avoid the toxic glands on the dorsal surface. This observation corroborates with Lavery (1969) who reported toad remains in gut-analyses of Black Kites in Townsville (along with Hylid and Lymnodynastine frogs).

One of us (AJ) has observed Black Kites hovering around the edge of dams presumably looking for prey and as Cane Toads are known to hide in hoof prints near the water during

the day (JMH, pers obs.) we suspect that they were actively searching for them.

Our observations suggest that Black Kites have adapted their behaviour to exploit this introduced amphibian despite its toxicity. Firstly it has learned to find and capture Cane Toads in their diurnal refuges. Secondly it has learned to eat the internal organs of the Cane Toad avoiding the toxins concentrated on the dorsal surface. Black Kites are an abundant predator in the Townsville region that could influence Cane Toad populations. We hypothesize that this predator, along with other native animals which are adapting their behaviour to eat Cane Toads, will reduce toad populations and hence the impact of this introduced amphibian on the Australian environment.

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David Mitchell, Arthur Jones & Jean-Marc Hero, Department of Zoology, James Cook University, Townsville Queensland 4811, Australia; 19 October 1995.

A NEW LOCALITY FOR THE HASTINGS RIVER MOUSE, *PSEUDOMYS ORALIS*, IN SOUTHEAST QUEENSLAND

IAN C. GYNTHYER AND PETER S. O'REILLY

Gynther, I.C. & O'Reilly, P.S. 1995 12 01: A new locality for the Hastings River Mouse, *Pseudomys oralis*, in southeast Queensland. *Memoirs of the Queensland Museum* 38(2):513-518. ISSN 0079-8835.

A Hastings River Mouse, *Pseudomys oralis*, was captured near O'Reilly's Rainforest Guesthouse on the western edge of Lamington National Park in December 1994. This is only the second locality at which the species has been trapped in Queensland in 25 years. The capture site, in the McPherson Range, is almost 70 km east of the *P. oralis* population recently discovered in Gambubal State Forest. The steep topography and comparatively dry vegetation at this new location differ considerably from those reported for previous Hastings River Mouse capture sites. These findings suggest that a wider variety of potential localities and environments should be targeted during future surveys of this species. □ *Pseudomys oralis*, new locality.

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The Hastings River Mouse, *Pseudomys oralis* (Rodentia: Muridae), is patchily distributed in mideastern Australia at altitudes between 400 m and 1250 m (Read, 1993a,b, pers. comm.; Tweedie & York, 1993). Until this study, thirty capture localities were known for the species - five in southeast Queensland and the remainder in northeast New South Wales (Hastings River Mouse Recovery Team, 1993; Fox et al., 1994). The first records of the Hastings River Mouse in Queensland were from the period 1969-1970, when animals were trapped at four separate localities southeast of Warwick (Kirkpatrick & Martin, 1971). Despite additional surveys (Read, 1988), the species was not seen again in this State for over 20 years. In 1993, it was 'rediscovered' near the original capture locations, but at higher altitude, in Gambubal State Forest (Poole, 1994).

Fossil evidence indicates that the present rarity of *P. oralis* is only the result of a relatively recent reduction in the species' distribution and abundance. Skeletal remains of the Hastings River Mouse were common from Holocene cave deposits associated with owl roosts along the Great Dividing Range in New South Wales and Victoria (Wakefield, 1972; Hall, 1974; Kirkpatrick, 1983). Furthermore, the co-occurrence of *P. oralis* and *Rattus rattus* remains at certain localities (Hall, 1974; Lee, 1995) suggests that even at the time of European settlement the distribution of the species was much greater than at present.

In light of this rapid contraction in range of the Hastings River Mouse and the paucity of infor-

mation on the species' distribution and ecology (Read, 1993b), conservation efforts have focused on locating remaining populations and identifying environmental features that may be used as indicators to predict additional localities for this rare rodent (King, 1984; King & Mackowski, 1986; Read, 1988, 1993a,b; Hastings River Mouse Recovery Team, 1993; Tweedie & York, 1993). In addition, dietary studies have recently been undertaken to assist in determining more precise habitat requirements of the Hastings River Mouse (Fox et al., 1994).

The present paper, documenting a newly discovered locality for *P. oralis* in Queensland, broadens existing knowledge of both the species' geographical distribution and the range of habitats in which it occurs. Importantly, this paper suggests that in Queensland, at least, the current 'search image' used by field workers to select potentially suitable Hastings River Mouse habitats may be too narrow.

METHODS

During a general mammal survey conducted in the vicinity of O'Reilly's Rainforest Guesthouse between December 11 and 16, 1994, a precipitous ridge known as Castle Crag near the western edge of Lamington National Park was chosen as one of many locations to sample for small mammals. Trapping effort at this particular site was low, with 24 size A Elliott traps, baited with salami and a mixture of peanut butter and rolled oats,



FIG. 1. Location of Castle Crag.

being set along the ridge crest over the two nights of December 15 and 16.

SITE DESCRIPTION

The trapping site ($28^{\circ}14'13''\text{S}$, $153^{\circ}07'06''\text{E}$), located 1.8 km WSW of O'Reilly's Rainforest Guesthouse, lies at an altitude of 790 m on the west-aligned Castle Crag ridge (Fig. 1). To the north, Morans Creek is some 250 m below and to the south, the Left Branch of the Albert River is 400 m lower in elevation. A wall of exposed basalt lies along the ridge crest (Fig. 2) and small rock outcrops and cliff faces are features of the southern slope.

Mean annual rainfall at O'Reilly's is 1643 mm, however, the trapping period coincided with the end of a severe drought. With precipitation totalling only 1013 mm, 1994 was the fourth driest year since 1917 when records at the Guesthouse began.

The vegetation at the trapping site consists of an open dry sclerophyll forest, with a canopy height of 8–10 m, growing on a shallow, brown

kraznozem (Fig. 3). The forest is dominated by *Eucalyptus banksii* and *Allocasuarina torulosa*, with an occasional *Lophostemon confertus* and a sparse shrub layer of *Xanthorrhoea glauca*. The steepness of the terrain (variable, but averaging c. 70°) and several fires within the last 14 years ensure a minimum of accumulated deadfall. The ground cover is primarily dense *Danthonia longifolia* growing to a maximum height of about 40 cm, although close to the ridge crest the cover provided by this grass is more sparse. Other species in the immediate vicinity of the trapping site were *Dendrobium kingianum*, forming a large clump approximately 25 cm high, *Daucus glochidiatus*, *Plectranthus graveolens*, *Wahlenbergia graniticola*, *Eupatorium adenophorum*, *E. riparium*, *Brachyscome ascendens*, *Helichrysum bracteatum*, *Rhodanthe anthemoides*, *Podolepis neglecta*, *Lepidosperma laterale*, *Dianella caerulea* var. *assera*, *Bulbine vagans*, *Cymbopogon refractus* and *Doodia aspera*. *Lomandra longifolia* was poorly represented in the understorey near the ridge top, but grew in scattered clumps some 30 m downhill of the trap line. The growth of mosses and small ferns lower on the slope indicated that soil mois-



FIG. 2. *P. oralis* capture site (arrowed) near basalt wall along the Castle Crag ridge crest.

ture is greater there than near the ridge crest. The vegetation of the much warmer northern side of the ridge was relatively sparse and included *Eucalyptus tereticornis*, *E. melliodora* and occasional *Acacia melanoxylon*.

Approximately 450m to the east, the ridge line broadens and the dry sclerophyll forest grades into very tall (35m) wet sclerophyll forest with a dense fern understorey. This gives way to notophyll vine forest after a further 130m. The nearest permanent water to the trapping site is the section of Morans Creek above Morans Falls, approximately 900m to the northeast. A small seepage area 800m to the northeast would only provide moisture after periods of rain.

RESULTS AND DISCUSSION

An adult Hastings River Mouse (Fig. 4) was captured on Castle Crag on the night of December 15, 1994. The successful trap was positioned on a small grassy ledge at the top of the southerly aspect, close to the exposed basalt wall (Fig. 2). No other mammals were caught in the trap line,

although a total of five Major Skinks, *Egernia frerei*, was also captured over the two nights. The *P. oralis* individual, a lactating female, was removed from the site and weighed, measured and photographed, before being released shortly afterwards at the point of capture. Its head and body (to vent) length was 135mm, tail to vent length 141mm, hind foot length 30mm and weight 85g. The identification was subsequently confirmed from the photographs by S. Van Dyck of the Queensland Museum.

Castle Crag is only the second locality at which *P. oralis* has been trapped in Queensland since the initial records of Kirkpatrick & Martin (1971) near Warwick in 1969-70. Lying approximately 68km east of the site where a population was recently discovered in Gambubal State Forest (Poole, 1994), it is well away from the general vicinity of previous captures. Indeed, the present locality on the northern fall of the McPherson Range (Fig. 5) is unique because all other specimens of the Hastings River Mouse in eastern Australia have been caught in close proximity to the Great Divide (Read, 1993a; Fox et al., 1994). Earlier, 'outlying' records of *P. oralis* do exist - identifiable bones were collected in 1976 from 'relatively fresh' owl pellets near Mapleton in the Blackall Range of southeast Queensland (Kirkpatrick, 1983; Read, 1988) and also in 1986 from a Grass Owl, *Tyto capensis*, pellet near Warrell in coastal New South Wales (G. Holmes, pers. comm.; Lee, 1995) - but the species has not yet been recorded alive at these localities.

The present record is of particular interest because of the nature of the topography and vegetation on Castle Crag. The altitude and rainfall at the site lie within the ranges recorded for previous Hastings River Mouse capture localities (King, 1984; King & Mackowski, 1986) and the general habitat is an open dry sclerophyll forest with a grassy understorey, as is typical for the species (e.g. King & Mackowski, 1986; Read, 1993b; Tweedie & York, 1993; Fox et al., 1994). An obvious difference, though, is that the forest canopy is much lower (8-10m) than the 20-40m upperstorey heights reported for other *P. oralis* sites (King, 1984; King & Mackowski, 1986; Townley, in press), due to the location on a narrow, exposed ridge on shallow soils. However, Read (1993b) concludes that the type or abundance of tree cover are probably not important factors in determining suitable habitat for the Hastings River Mouse, and so details of the forest structure on Castle Crag may not be especially critical. A more significant difference is that most



FIG. 3. Southern slope of Castle Crag from *P. oralis* capture site.

other capture sites possess stands of sedges (Cyperaceae and Juncaceae, particularly *Carex*, *Cyperus* and *Juncus*) growing in association with either permanent water in creeks and gullies or with bogs, soaks or seepage areas on ridges and mid-slopes (Read, 1988, 1993a,b; Hastings River Mouse Recovery Team, 1993; Tweedie & York, 1993; Lee, 1995). Such moist conditions do not exist on Castle Crag. Permanent water is not accessible and the lack of terracing on the steep slope has prevented the formation of boggy areas which would enable the growth of stands of these sedges (cf. Read, 1993a,b). Also, there are no seepage areas nearby and ground moisture is apparently insufficient to support species of *Carex*, *Cyperus* or *Juncus*. The only sedge present, *Lepidosperma laterale*, is represented by individual plants sparsely distributed through the understorey.

Of the ground cover species recorded at Castle Crag, only *Lomandra longifolia*, *Lepidosperma laterale* and *Doodia aspera* have been reported in the understorey at other captures sites (King,

1984; King & Mackowski, 1986; Hastings River Mouse Recovery Team, 1993; Read, 1993b; Fox et al., 1994), suggesting a difference in habitat type at this new locality. The sedge *L. laterale* has never been recorded in the diet of *P. oralis*, but seed head material from *Lomandra longifolia* and pollen from an unidentified species of mat-rush are known to be eaten by the Hastings River Mouse (Fox et al., 1994; A. Smith & D. Quin, unpublished data), although Read (1993b) does not consider *L. longifolia* to be an indicator of suitable *P. oralis* habitat where it occurs on hill sides. On separate occasions, S. Townley (pers. comm.) has observed radio-tracked animals in Billilimba State Forest in New South Wales eating *Doodia aspera* and an undetermined species of *Plectranthus*. Leaf and seed head material tentatively identified as originating from a *Plectranthus* sp. was also found during a dietary analysis of the Hastings River Mouse in the same State Forest (A. Smith & D. Quin, unpublished data). *Plectranthus graveolens* is present at Castle Crag and may, together with *Doodia*, represent a food resource for the Hastings River Mouse there. Clearly, an analysis of faecal pellets from animals at the Lamington National Park site would provide valuable information about what plant species and items are eaten and would assist in refining current knowledge of habitat features that are critical for *P. oralis* at this and other locations.

The Hastings River Mouse capture site in Gambubal State Forest shares some similarities with the present one in that it is also distant from surface water and is adjacent to a rocky escarpment (Hastings River Mouse Recovery Team, 1993; Poole, 1994). S. Townley (pers. comm.) has found that individual animals in Gambubal State Forest use cracks and crevices in rocks of

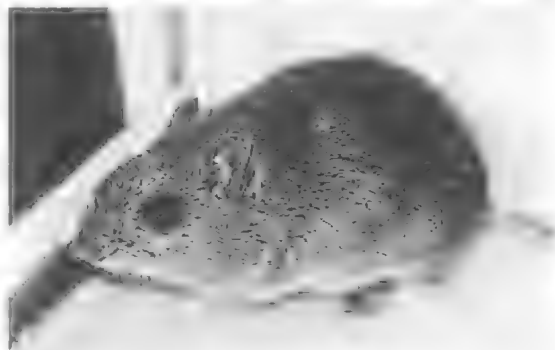


FIG. 4. Adult female *P. oralis* captured at Castle Crag.

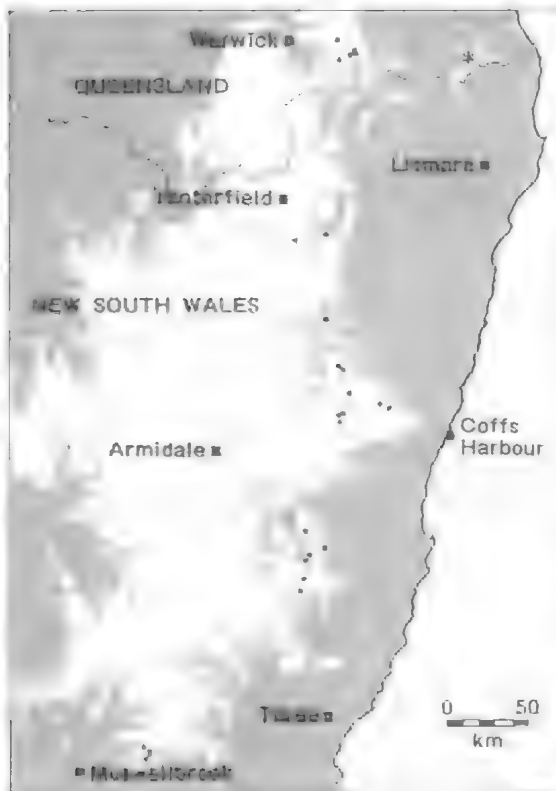


FIG. 5. The location of Castle Crag (asterisk) in relation to previous *P. oralis* capture sites in eastern Australia (dots). The area shaded grey is land below 500m elevation. Four sites in New South Wales discovered since 1993 (Fox et al., 1994) are not shown. (Adapted from Read, 1993a).

the cliff face for shelter. The same may be true on Castle Crag, where potentially suitable nesting locations in areas of exposed rock were numerous. There are, however, fundamental differences between these two Queensland sites. Substantially more habitat area is available for the species at Gambubal State Forest, most occurring on flat or gently sloping terrain, and conditions there are more lush, with the grassy, tall open forest abutting notophyll vine forest across an abrupt ecotone. The open forest of this ecotonal area has recently been found to support significant quantities of the sedge *Carex breviculmis* (Y. Ross, pers. comm.). By contrast, as previously stated, no *Carex* spp. occur at the capture site in Lamington National Park and the nearest notophyll vine forest is almost 600m away.

Given that the female Hastings River Mouse reported here was in a reproductive state and,

therefore, unlikely to be a transient individual at the site, this record indicates that Castle Crag supports a viable, even if isolated, population of *P. oralis*. Furthermore, it extends the diversity of habitat types the species is known to utilise and suggests a broader range of localities and environments should be targeted during future surveys for the Hastings River Mouse, particularly in Queensland. Additional work to determine the population size and distribution of *P. oralis* in the Lamington National Park area is currently being undertaken to clarify the status of the species in this State.

ACKNOWLEDGEMENTS

The O'Reilly's Rainforest Guesthouse initiated and facilitated the trapping program, which was undertaken by IG as part of the NatureSearch project. We are grateful to Steve Van Dyck, Queensland Museum, for the loan of additional traps and for much helpful discussion. We would also like to thank Greg Gordon and Noleen Kunst, Queensland Department of Environment and Heritage, and Sally Townley, Southern Cross University, for their comments on an earlier draft of this paper. Staff of the Queensland Herbarium provided identifications of the herbaceous plant specimens and David Read kindly supplied the original artwork to enable us to produce Fig. 5.

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THE BUTTERFLY TYPES OF W. H. MISKIN IN THE QUEENSLAND MUSEUM (LEPIDOPTERA)

DAVID L. HANCOCK

Hancock, D.L. 1995 12 01: The butterfly types of W.H. Miskin in the Queensland Museum (Lepidoptera). *Memoirs of the Queensland Museum* 38(2): 519-528. Brisbane. ISSN 0079-8835.

Notes are provided on the type specimens of the 65 species of Australian butterflies described between 1874 and 1891 by W. H. Miskin. □ type specimens, *Lepidoptera*.

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William Henry Miskin published 19 papers on Australian butterflies between 1871 and 1891. Descriptions of 65 new butterfly taxa were published in 11 papers (Miskin 1874c, 1876, 1884b, 1889a, 1889c, 1889d, 1889e, 1890a, 1890b, 1890c, 1891), whilst a further 8 papers (Miskin, 1871, 1874a, 1874b, 1883, 1884a, 1888, 1889b, 1890d) appeared in which no new taxa were described.

Miskin did not place type or determination labels on his specimens and in most cases the number of specimens used for each description is unknown. Were it not for his meticulous handwritten notebooks, now preserved in the Queensland Museum, in many cases it would be impossible to determine which specimens are in fact types. Fortunately, Miskin applied a species number to each specimen in his collection and this corresponds with those listed for each species in his notebooks. In many cases locality labels are also absent but for those specimens from his own collection the locality appears to be Brisbane. In the list below, numbers given in brackets after the species' citations are those allocated to the species in Miskin's notebooks. Species without a number were not present in his collection.

In July 1910, G. A. Waterhouse (Australian Museum) and C. J. Wild (Queensland Museum) added type labels to many of Miskin's syntypes, but in 2 cases they also added labels to specimens that are not types. A copy of G. A. Waterhouse's notes on the collection made during his 1910 examination is kept at the Australian National Insect Collection, Canberra. Reference to these notes has been made where appropriate. The number of specimens listed for the various species in Miskin's Collection by Waterhouse in 1910 and the number currently located sometimes differ but in at least some cases Waterhouse's lists also include specimens added

to Miskin's Collection subsequent to his descriptions.

Of the 65 nominal species described by Miskin, holotype, lectotype or syntype material has been located in the Queensland Museum for 53 species. Seven species were described from the Lucas Collection, 1 from the Australian Museum Collection. Two of the Lucas species are represented by types in the South Australian Museum. Types of 4 species supposedly in the Queensland Museum have not been located. Lectotypes have been designated directly by Sands (1986) and by De Baar & Hancock (1993) and "by inference of Holotype", under the rules of the International Commission on Zoological Nomenclature, by Eliot & Kawazoe (1983), Sands (1980) and Waterhouse (1933, 1937).

Thirty-five taxa remain valid at the species or subspecies level, the remainder are synonyms. Determination labels and Type numbers (QMT12342 to QMT12440) have been added to each specimen by the present author.

TYPE SPECIMENS

Family PAPILIONIDAE

Papilio egiptus Miskin, 1876:451 (190)

Described from 3 males and 1 female collected by H. Kuntzler [in late 1875 or early 1876] at Rockingham Bay (= Cardwell), Qld. Only the 2 males from Miskin's Collection have been located; the pair originally deposited in the Queensland Museum (Miskin 1876) was not located by Waterhouse in 1910 and still has not been found.

SYNTYPES: 2 ♂ (QMT12342, QMT12343); H.K. Cardwell/190 ♂.

CURRENT STATUS: *Priniceps ambrax egiptus* (Miskin).

Family PIERIDAE

***Delias nigridius* Miskin, 1884b:93 (214)**

Described from an unknown number of females collected by Miskin at Rockingham Bay and Johnstone River, Qld. Although the original description stated "♂", it was actually a female being described; the discussion noted that only females were known. The male was described subsequently (Miskin 1889a: 1515). Two females and a male have been located. SYNTYPES: 2♀ (QMT12344, QMT12345). -/5/82 Cardwell/214. One ♀ subsequently labelled: Misk. Type ♀; 28/7/10, GAW, CJW (on reverse). METALLOTYPE (not an original type): 1♂ (QM): Johnstone R/214. Subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse)/ L/3011. CURRENT STATUS: *Delias ennia nigridius* Miskin.

***Elodina perdita* Miskin, 1889e:263 (44)**

Described from an unknown number of specimens collected by Augustus Simson at Port Denison (= Bowen), Qld. Two of the 3 specimens noted by Waterhouse are regarded as types. These were designated Lectotype and paralectotype by De Baar and Hancock (1993). The paralectotype female has the hindwing underside yellow. The third specimen, a female with the hindwing underside white, is labelled "Bowen/184". In Miskin's notebook, species number 184 is listed as *Elodina egnatia* and this specimen cannot be regarded as part of Miskin's original type series.

LECTOTYPE: ♂ (QMT12346), A.S., B. Bowen/ 44. Subsequently labelled: Lectotype ♂, *Elodina perdita* Miskin, desig. M. de Baar & D. L. Hancock 1992 [red label].

PARALECTOTYPE: ♀ (QMT12347), A.S., C. Bowen/44. Subsequently labelled: Paralectotype ♀, *Elodina perdita* Miskin, desig. M. de Baar & D. L. Hancock, 1992.

CURRENT STATUS: *Elodina perdita* Miskin.

***Tachyris asteria* Miskin, 1889a:1514**

Described from a male from Port Douglas, Qld in the Lucas Collection. Miskin's notebook indicates only 1 specimen; it has not been located.

CURRENT STATUS: Synonym of *Appias melania* (Fabricius, 1775).

***Terias immaculata* Miskin, 1889d:258 (84)**

Described from an unknown number of specimens collected at Rockhampton, Qld. One of the 4 specimens noted by Waterhouse has been located.

SYNTYPE: 1♂ (QMT12348), -/1/75 Rockhampton/84. The following labels were added subsequently: Misk. Type ♂?; 27/7/10, GAW, CJW (on reverse)/ L/3013/ ? *Terias immaculata*.

CURRENT STATUS: Synonym of *Eurema herla* (W. S. Macleay, 1826).

***Terias lineata* Miskin, 1889d:257**

Described from 2 specimens from North Queensland in the Lucas Collection. Not located.

CURRENT STATUS: Synonym of *Eurema sana* (Butler, 1877).

***Terias varius* Miskin, 1889d:259 (14)**

Described from an unknown number of specimens collected at Brisbane and Rockhampton. Three of the 5 specimens noted by Waterhouse have been located. Specimens from Dawson River (Expedition Range, inland from Rockhampton) appear to have been in Miskin's Collection since at least 1875 (see discussion of *Ogyris barnardi*) and the female is therefore included as a syntype.

SYNTYPES: 1♂ (QMT12349): G.B. [? or G.P.], A. Rockhn./14; 1♂ (QMT12350): 14; 1♀ (QMT12351): Dawson R./D/14. The unlabelled male is probably from Brisbane.

CURRENT STATUS: Synonym of *Eurema smilax* (Donovan, 1805).

Family NYMPHALIDAE
Subfamily DANAINAE***Euploea amycus* Miskin, 1890a:1044 (187)**

Described from an unknown number of both sexes collected at Cape York, Qld. Two specimens have been located.

SYNTYPES: 1♂ (QMT12352): Cape York/187. Subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse)/ L/3003/ *E. amycus* ♂; This specimen was taken for Fig. 18 in "The Butterflies of Australia", by Waterhouse & Lyell (on reverse). 1♀ (QMT12353): F.M. -/5/75, Cape York/187. Subsequently labelled: Misk. Type ♀; 28/7/10, GAW, CJW (on reverse)/ L/3002.

CURRENT STATUS: Synonym of *Euploea algea violettii* (Butler, 1876) (Dunn & Dunn 1991).

***Euploea boreas* Miskin, 1890a:1043 (189)**

Described from an unknown number of both sexes collected by H. Kuntzler at Cardwell, Qld. Three specimens have been located. Waterhouse's 1910 notes indicate that a further male from Herbert R. best fitted the description of the type but this locality was not mentioned by Miskin (1890a) and the specimen may have been added subsequently.

SYNTYPES: 2♂ (QMT12354, QMT12355): H.K. Cardwell/189 ♂, 1♀ (QMT12356): H.K. Cardwell/189 ♀.

The female subsequently labelled: Misk. Type ♀; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: Synonym of *Euploea alcathoe eichhorni* Staudinger, 1884.

***Euploea crithon* Miskin, 1890a:1042 (188)**

Described from an unknown number of males collected at Cape York, Qld. Two specimens have been located.

SYNTYPES: 1 ♂ (QMT12357): Cape York/188. Subsequently labelled: *E. doriecha* ? *crithon*; This specimen was taken for Fig. 32 in "The Butterflies of Australia", by Waterhouse & Lyell (on reverse). 1 ♂ (QMT12358): [no original labels]. Subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse)/ L/3002.

CURRENT STATUS: Form of *Euploea sylvester* (Fabricius, 1793).

***Euploea dardanus* Miskin, 1890a:104 (204)**

Described from (probably one) male collected at Cape York, Qld.

SYNTYPE: 1 ♂ (QMT12359): Cape York/204. Subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse)/ L/2998.

CURRENT STATUS: Form of *Euploea sylvester* (Fabricius, 1793).

***Euploea euclus* Miskin, 1890a:1045 (203)**

Described from an unknown number of both sexes collected at Cape York, Qld. Two specimens have been located.

SYNTYPES: 1 ♂ (QMT12360): C. York/203; 1 ♀ (QMT12361): Cape York/203/6. Both subsequently labelled: Misk. Type ♂ [or ♀]; 28/7/10, GAW, CJW (on reverse)/ L/2999/ *E. chaufa corinna* ab. *euclus* ♂ [or ♀]; This specimen was used for Fig. 21 [or 23] in "The Butterflies of Australia", by Waterhouse & Lyell (on reverse).

CURRENT STATUS: Form of *Euploea cure corinna* (W.S. Macleay, 1826).

***Euploea hippias* Miskin, 1890a:1040 (206)**

Described from (probably one) male collected at Cape York, Qld.

SYNTYPE: 1 ♂ (QMT12362): E.W. Cape York/206. Subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse)/ L/3000/ *E. hirdafa hippias* ♂; This specimen was taken for Fig. 17 in "The Butterflies of Australia", by Waterhouse & Lyell (on reverse).

CURRENT STATUS: Synonym of *Euploea usipetes* Hewitson, 1858.

***Euploea misenus* Miskin, 1890a:1039 (183)**

Described from (probably one) male collected at Cape York, Qld.

SYNTYPE: 1 ♂ (QMT12363): Cape York/183. The following labels added subsequently: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse)/ L/3001/ *E. misenus* ♂; This specimen was taken for Fig. 14 in "The Butterflies of Australia", by Waterhouse & Lyell (on reverse).

CURRENT STATUS: Synonym of *Euploea alcathoe monilifera* (Moore, 1883).

Subfamily NYMPHALINAE

***Atella propinqua* Miskin, 1884b:94 (215)**

Described from an unknown number of specimens collected at Rockingham Bay, Qld. Two of the 3 specimens noted by Waterhouse have been located.

SYNTYPES: 1 ♂ (QMT12364): Cardwell/ 215; 1 ♀ (QMT12365): -/5/82 Cardwell/ 215/Female. The female subsequently labelled: Misk. Type; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: *Vagrans egista propinqua* (Miskin).

***Pyrameis lucasii* Miskin, 1889a:1515**

Described from 1 specimen from Fernshawe, Victoria, in the Lucas Collection. It has not been located.

CURRENT STATUS: Synonym of *Vanessa kershawi* ab. *suffusa* (Olliff, 1888).

Subfamily SATYRINAE

***Epinephile rawnsleyi* Miskin, 1876:454 (149)**

Described from 1 specimen collected by H. C. Rawnsley at Maroochy River, near Brisbane, Qld.

HOLOTYPE: ♂ (QMT12366): Maroochnee/HCR. 149. Subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: *Tisiphone abeona rawnsleyi* (Miskin).

***Heteronympha digglesii* Miskin, 1876:454 (192)**

Described from an unknown number of specimens (all males) collected at Brisbane, Qld. Two males have been located.

SYNTYPES: 2 ♂ (QMT12367, QMT12368): 192. One subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: Synonym of *Heteronympha mirifica* (Butler, 1866).

***Mycalesis modestus* Miskin, 1890c:29 (198)**

Described from an unknown number of specimens collected at Cooktown, Qld. Two of the 3 specimens noted by Waterhouse have been located.

SYNTYPES: 1 ♂ (QMT12369): D.K. Cooktown/198; 1 ♀ (QMT12370): D.M.B. Cooktown/198.

CURRENT STATUS: Synonym of *Mycalesis perseus* (Fabricius, 1773).

Xenica kershawi Miskin, 1876:452 (200)

Described from an unknown number of both sexes collected by W. Kershaw in Victoria. Two specimens have been located.

SYNTYPES: 1 ♂ (QMT12371), 1 ♀ (QMT12372): W.K. Victoria/200/♂ [or ♀]. The male subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: *Oreixenica kershawi* (Miskin).

Family LYCAENIDAE

Arhopala cyronthe Miskin, 1890c:43 (178)

Described from 2 males collected at Cape York and Bowen.

SYNTYPES: 1 ♂ (QMT12373): Cape York/178. Subsequently labelled Misk. Type ♂; 28/7/10, GAW, CJW (on reverse)/ L/3010. 1 ♂ (QMT12374): Bowen/ 178.

CURRENT STATUS: Synonym of *Arhopala micale amytis* (Hewitson, 1862). The Bowen specimen is referable on geographical grounds to *A. micale amytis* Waterhouse, 1942, placed as a synonym of *A. m. amytis* by Dunn & Dunn (1991).

Arhopala eupolis Miskin, 1890c:42 (136)

Described from an unknown number of both sexes collected at Cape York, Cooktown and Cardwell. Six specimens have been located.

SYNTYPES: 1 ♂ (QMT12375): Cape York/136; 1 ♂ (QMT12376): H.K. Cardwell/136; 2 ♀ (QMT12377, QMT12378): - /5/82 Cardwell/136; 1 ♀ (QMT12379): J.H. Cooktown/136; 1 ♀ (QMT12380): 136. The male and 1 female from Cardwell subsequently labelled: Misk. Type ♂ [or ♀]; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: Synonym of *Arhopala centaurus* (Fabricius, 1775).

Arhopala wildei Miskin, 1891:71

Described from 1 male and 1 female collected by C. J. Wild at Cairns, Qld. Miskin (1891) consistently misspelt Wild's name as Wilde.

SYNTYPES: 1 ♂ (QMT12381), 1 ♀ (QMT12382): [no original labels]. Subsequently labelled: L/3006/ Misk. Type ♂ [or ♀]; 28/7/10, GAW, CJW (on reverse). Female also labelled: *Arhopala wildei* ♀.

CURRENT STATUS: *Arhopala wildei* Miskin.

Chrysophanus aenea Miskin, 1890c:33 (175)

Described from an unknown number of both sexes collected in Queensland as far north as Bowen. Three of the 4 specimens noted by Waterhouse have been located; the male from Bowen has not been found.

SYNTYPES: 1 ♂ (QMT12383), 1 ♀ (QMT12384): 175. Subsequently labelled: Misk. Type ♂ [or ♀]; 28/7/10, GAW, CJW (on reverse), 1 ♀ (QMT12385): Moggill/ 175. All these specimens are probably from Brisbane.

CURRENT STATUS: Synonym of *Paralucia pyrodiscus* (Doubleday, 1847) (Edwards 1991).

Danis coelestis Miskin, 1891:50 (239)

Described from an unknown number of both sexes collected by C. J. Wild at Cairns, Qld. Two males have been located. Although the species was described from specimens in the Queensland Museum, the specimen labelled Cairns (from Miskin's own collection) is undoubtedly from the type series since Miskin gave collection number 240 to specimens of *Danis serapis* described at the same time. Only those species in his own collection were numbered.

SYNTYPES: 1 ♂ (QMT12386): Cairns/239; 1 ♂ (QMT12387): [no locality data]/ *Danis coelestis* ♂ Misk. The latter specimen subsequently labelled: Misk. Type ♂; GAW (on reverse).

CURRENT STATUS: *Jamides aleuas coelestis* (Miskin).

Danis serapis Miskin, 1891:49 (240)

Described from numerous specimens of both sexes collected at Cairns and by H. Kuntzler at Cardwell, Qld. Three of the 4 specimens noted by Waterhouse have been located.

SYNTYPES: 1 ♂ (QMT12388), 2 ♀ (QMT12389, QMT12390): H.K. Cardwell/240. One specimen of each sex subsequently labelled: Misk. Type ♂ [or ♀]; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: *Danis danis serapis* Miskin.

Danis syrius Miskin, 1890c:34 (224)

Described from an unknown number of both sexes (actually all males) collected in North Queensland. Two males have been located; one was described as a female.

SYNTYPES: 1 ♂ (QMT12391): C. York/224. Subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse). 1 ♂ (QMT12392): N. Queensd./224. Subsequently labelled: Misk. Type ♂ = a male; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: *Danis danis syrius* Miskin.

Deudorix democles Miskin, 1884b:95 (222)

Described from an unknown number of specimens collected at Basilisk Range (Johnstone R.), Qld. Wa-

terhouse (1902) noted there were 2 males; his 1910 notes record the additional data 5/83.

SYNTYPES: 2♂ (QMT12393, QMT12394); Basilisk Range/222. One subsequently labelled: Misk. Type ♂; 27/7/10, GAW, CJW (on reverse); both also labelled: Fig. 276 (upperside) [or 277 (underside)] in "The Butterflies of Australia" by Waterhouse & Lyell was taken from this specimen.

CURRENT STATUS: *Virachola democles* (Miskin).

Deudorix simsoni Miskin, 1874c:165 (102)

Described from an unknown number of both sexes collected by Augustus Simson at Port Denison (= Bowen) and by Miskin at Brisbane, Qld. Five syntypes have been located. A female in QM labelled 'Dovercourt [Miskin's home in Toowong, Brisbane], Ap '74/ 102/ Misk. Type ♀; 28/7/10, GAW, CIW (on reverse)' is not a type; the original description is dated 18 March 1874, before the specimen was collected.

SYNTYPES: 1♂ (QMT12395), 1♀ (QMT12396); 102♂ [or ♀]; 1♂ (QMT12397), 1♀ (QMT12398): 102. The first specimen subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse); all these specimens are probably from Brisbane. 1♂ (QMT12399): A.S., A. Bowen/ 102.

CURRENT STATUS: *Rapala varana simsoni* (Miskin).

Holochila albosericea Miskin, 1891:65 (159)

Described from an unknown number of both sexes collected by George Barnard at Expedition Range (= Dawson R.), inland from Rockhampton, Qld. Two of the 3 males noted by Waterhouse have been located. These appear to have been in Miskin's Collection since at least 1875 (see discussion of *Ogyris barnardi*).

SYNTYPES: 2♂ (QMT12400, QMT12401): Dawson R./159. One subsequently labelled: Misk. Type; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: *Nesolycaena albosericea* (Miskin).

Holochila androdus Miskin, 1890c: 41 (164)

Described from an unknown number of both sexes from Cape York and Cooktown, Qld. Two specimens have been located.

SYNTYPES: 1♂ (QMT12402): Cape York; Cockerell, My '73 (on reverse)/164; 1♀ (QMT12403): Cooktown/164. Both subsequently labelled: Misk. Type ♂ [or ♀]; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: Synonym of *Candalides helenita* (Semper, 1879).

Hypochrysops apollo Miskin, 1891: 85 (243)

Described from a supposed female (actually a male) collected by Rowland Turner at Herbert River, Qld. It is in poor condition, having been flattened between the pages of a book.

HOLOTYPE: ♂ (QMT12404): R.T. Herbert R./243. Subsequently labelled: Misk. Type ♀= ♂; 28/7/10, GAW, CJW (on reverse)/ L/3004/ Specimen photog. for CHECKLIST AUST LEP Film 186/11.

CURRENT STATUS: *Hypochrysops apollo* Miskin.

Hypochrysops epicurus Miskin, 1876:455 (114)

Described from an unknown number of both sexes collected at Brisbane, Qld. Two specimens have been located. These were designated Lectotype and paralectotype by Sands (1986), with the collection number recorded incorrectly as 124.

LECTOTYPE: ♂ (QMT12405): 114. Subsequently labelled: Misk. Type ♂; 27/7/10, GAW, CJW (on reverse)/ Lectotype *Hypochrysops epicurus* Miskin, 1876, designated 1986, D. P. A. Sands (red label).

PARALECTOTYPE: 1♀ (QMT12406): [label glued to insect and number not visible]. Subsequently labelled: Misk. Type ♀; 27/7/10, GAW, CJW (on reverse)/ Paralectotype *Hypochrysops epicurus* Miskin, 1876, designated 1986, D. P. A. Sands (blue label).

CURRENT STATUS: *Hypochrysops epicurus* Miskin.

Hypochrysops euclides Miskin, 1889a: 1517

Described from an unknown number of both sexes from Gippsland, Victoria in the Lucas Collection. The type locality is evidently erroneous (Sands 1986) since this taxon occurs only in North Queensland. Syntypes not located; believed destroyed (Waterhouse 1903).

CURRENT STATUS: *Hypochrysops pythias euclides* Miskin.

Hypochrysops hecalius Miskin, 1884b:94 (218)

Described from (probably one) female collected by W. Kershaw in Victoria, designated Lectotype by Sands (1986). Miskin (1889a: 1516) subsequently described the male from the Lucas Collection.

LECTOTYPE: ♀ (QMT12407): W.K. Victoria/218. Subsequently labelled: Misk. Type ♀; 27/7/10, GAW, CJW (on reverse)/ Lectotype *Hypochrysops hecalius* Miskin, 1884, designated 1986, D. P. A. Sands (red label).

CURRENT STATUS: *Hypochrysops byzns hecalius* Miskin.

Hypochrysops olliffi Miskin, 1889a:1518 (237)

Described from a single male collected by A. S. Olliff. The original description gave the type locality as both Newcastle, NSW and Fremantle, WA. The Holotype was stated to be in the Australian Museum (Miskin 1889a) but Waterhouse and Lyell (1914) noted that no specimens from Newcastle were present there and restricted the type locality to SW Western Australia. A specimen without locality data (KL 23213) in the Aus-

tralian Museum is possibly the holotype (Sands 1986). The locality Newcastle must be considered an error, although Miskin (1889a:1520) evidently believed the species occurred in eastern coastal Australia. It is possible that the locality Fremantle was intended as a correction rather than an addition.

In the QM Collection are 2 specimens (1♂, 1♀), labelled "*Olliffi*, NSW/237". These are specimens of typical *H. ignitus ignitus* (Leach) and were evidently added to Miskin's collection after his description of *H. olliffi*, since he noted (1889a) that the female was unknown.

CURRENT STATUS: *Hypochrysops ignitus olliffi* (Miskin).

***Jalmenus eubulus* Miskin, 1876: 457 (91)**

Described from an unknown number of specimens from Rockhampton, Qld. Three specimens have been located. The Dawson River males appear to have been in Miskin's Collection since at least 1875 (see discussion of *Ogyris barnardi*) and are regarded as syntypes. The Rockhampton female probably came from further inland, since this taxon is not known from coastal areas (Common & Waterhouse 1981); like the Dawson R. specimens, it may have been collected by George Barnard.

SYNTYPES: 1♀ (QMT12408): G.P. [? or G.B.], A., Rockhampton/91. Subsequently labelled: Misk. Type ♀, 28/7/10, GAW, CJW (on reverse), 2♂ (QMT12409, QMT12410): Dawson R./91.

CURRENT STATUS: *Jalmenus evagoras eubulus* Miskin.

***Jalmenus itonus* Miskin, 1890c: 41 (152)**

Described from an unknown number of males collected at Cape York, Qld. Waterhouse's 1910 notes list 2 males; 1 has been located.

SYNTYPE: 1♂ (QMT12411): Cape York/152. Subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: Synonym of *Jalmenus eichhorni* Staudinger, 1888.

***Lycaena canescens* Miskin, 1890c:35 (163)**

Described from (probably one) specimen collected by (?) Charles French in Tasmania.

SYNTYPE: 1♂ (QMT12412): C.F. Tasmania/163. Subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: Synonym of *Candalides arastus* (Cox, 1873).

***Lycaena graellis* Miskin, 1890c:37 (162)**

Described from an unknown number of both sexes collected from Brisbane to Cooktown, Qld. Two spec-

imens (from Rockhampton and Brisbane) of the 7 noted by Waterhouse have been located.

SYNTYPES: 1♂ (QMT12413): Rockhⁿ/162; 1♀ (QMT12414): Toowong, Mar. '73/162.

CURRENT STATUS: Synonym of *Famegana alsulus* (Herrich-Schaeffer, 1869).

***Lycaena hobartensis* Miskin, 1890c:38 (223)**

Described from an unknown number of specimens collected by Gervase F. Mathew at Hobart, Tasmania. Waterhouse's 1910 notes list a pair but only the male has been located.

SYNTYPE: 1♂ (QMT12415): G.F.M. Hobart/ 223. Subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: *Neolucia hobartensis* (Miskin).

***Lycaena mackayensis* Miskin, 1890c:35 (230)**

Described from (probably one) male collected at Mackay, Qld. Waterhouse's 1910 notes also record the data R. Turner], 2/89.

SYNTYPE: 1♂ (QMT12416): Mackay/230. Subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse)/ *L. mackayensis* Misk. 230.

CURRENT STATUS: Synonym of *Prosotas dubiosa* (Semper, 1879).

***Lycaena mathewi* Miskin, 1890c:38 (89)**

Described from (probably one) specimen collected by Gervase F. Mathew at Sydney, NSW. Waterhouse's 1910 notes record the additional data 12/82.

SYNTYPE: 1♀ (QMT12417): G.F.M. Sydney/89. Subsequently labelled: Misk. Type ♀; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: *Neolucia mathewi* (Miskin).

***Lycaena nigra* Miskin, 1890c:36 (216)**

Described from an unknown number of "females" collected at Cardwell, Qld. Waterhouse's 1910 notes list a pair but only the male (described as a female) has been located.

LECTOTYPE: ♂ (QMT12418): -/5/82 Cardwell/216. Subsequently labelled: Misk. Type ♀ = ♂; 28/7/10, GAW, CJW (on reverse). Called Holotype by Eliot and Knwazoe (1983), thereby designated as Lectotype "by inference of Holotype" under the rules of the ICZN.

CURRENT STATUS: *Megisbe strongyle nigra* (Miskin).

***Lycaena sulpitius* Miskin, 1890c:37 (181)**

Described from (probably one) specimen collected at Rockhampton, Qld.

SYNTYPE: 1♂ (QMT12419): Rockhⁿ/181 [red ink]. Subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: *Theclinesthes sulpitius* (Miskin).

***Lycaena tenella* Miskin, 1891:63**

Described from (probably one) female collected by C. J. Wild at Cairns.

LECTOTYPE: ♀ (QMT12420): [no locality data]/ *Lyc. tenella* n. sp. ♀. Subsequently labelled: Misk. Type ♀; 28/7/10, GAW, CJW (on reverse). Called Holotype by Eliot and Kawazoe (1983), thereby designated as Lectotype "by inference of Holotype".

CURRENT STATUS: *Udara tenella* (Miskin).

***Lycaenesthes tasmanicus* Miskin, 1890c:40 (195)**

Described from (probably one) male collected by Sylvester Diggles supposedly in Tasmania. The type locality was doubted by Miskin (1891) who recorded the species from Cairns. Waterhouse's 1910 notes indicate a male from "Cape York or Tasmania". The type-locality is evidently erroneous.

SYNTYPE: 1♂ (QMT12421): S.D. 22/11/75 Tasmania/195. Subsequently labelled: Misk. Type ♂; 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: *Erysichton palmyra tasmanicus* (Miskin).

***Lycaenesthes turneri* Miskin, 1890c:39 (180)**

Described from an unknown number of both sexes collected at Cape York, Cardwell and Mackay (1 pair). Four specimens have been located, at least one collected by Rowland Turner at Mackay.

SYNTYPES: 1♂ (QMT12422): Cape York/180; 1♀ (QMT12423): -/5/82 Cardwell/180; 1♂ (QMT12424): Mackay/180; 1♀ (QMT12425): R.T. Mackay/180. The Mackay specimens subsequently labelled: Misk. Type ♂ (or ♀); 28/7/10, GAW, CJW (on reverse).

CURRENT STATUS: Synonym of *Anthene lycaenoides godeffroyi* (Semper, 1879).

***Ogyris barnardi* Miskin, 1890b:27 (174)**

Described from an unknown number of both sexes collected by George Barnard at Dawson River (= Expedition Range), Qld. Two specimens have been located. These appear to have been in Miskin's Collection since at least 1875, since collection numbers up to 200 appear for species described by Miskin (1876) and species numbers 187 (*Euploea umycus*) and 195 (*Lycaena tasmanicus*) were collected in May and November 1875 respectively.

SYNTYPES: 1♂ (QMT12426), 1♀ (QMT12427): Dawson R./174. Both subsequently labelled: Misk. Type ♂ (or ♀); 28/7/10, GAW, CJW (on reverse). Male also labelled: Specimen photog. for CHECKLIST AUST LEP Film 186/12; female also labelled: L/3009. The female has lost its hindwings.

CURRENT STATUS: *Ogyris barnardi* Miskin.

***Pseudodipsas brisbanensis* Miskin, 1884b:95 (202)**

Described from (probably one) female collected at Brisbane, Qld.

LECTOTYPE: ♀ (QMT12428): 202. Subsequently labelled: Misk. Type ♀; 28/7/10, GAW, CJW (on reverse)/ T6193, Type (red label)/ Specimen photog. for CHECKLIST AUST LEP Film 186/10. Called Holotype by Sands (1980), thereby designated Lectotype "by inference of Holotype".

CURRENT STATUS: *Acrodipsas brisbanensis* (Miskin).

***Pseudodipsas fumidus* Miskin, 1889c:264**

Described from an unknown number of both sexes from Brisbane, Qld, in the Lucas Collection. Not located.

CURRENT STATUS: Synonym of *Pseudodipsas cephenes* Hewitson, 1874.

***Pseudodipsas innotatus* Miskin, 1874c:165 (98)**

Described from an unknown number of both sexes collected by Miskin at Brisbane, Qld. None of the original specimens has been located; the 2 males and 1 female listed by Waterhouse in his 1910 notes may have been added subsequently. It is species number 98 in Miskin's notebook.

This species was treated as a synonym of *P. ilias* (Felder) by Miskin (1891).

CURRENT STATUS: *Philiris innotata* (Miskin).

Family HESPERIIDAE***Apastus minimus* Miskin, 1889c: 153 (227)**

Described from an unknown number of specimens collected in Victoria and Western Australia. None of the 4 males listed by Waterhouse in his 1910 notes (where he recorded the type as a Victorian male) has been located, although Waterhouse (1937) called a specimen from Western Australia (then in QM) the Holotype, thereby designating the Lectotype "by inference of Holotype". The species is numbered 227 in Miskin's notebook.

CURRENT STATUS: Synonyms of *Taractrocera papyria papyria* (Boisduval, 1832) (Victorian specimens) and *T. papyria agraulia* (Hewitson, 1868) (WA specimens, including Lectotype). This synonymy was also suggested by Miskin (1891: addenda).

***Hesperilla atromacula* Miskin, 1889c: 148 (234)**

Described from an unknown number of males collected in Victoria. Two have been located.

Waterhouse's 1910 notes also list a female; this was presumably added later to Miskin's Collection.

LECTOTYPE: ♂ (QMT12429): Victoria/234. Subsequently labelled: Misk. Type ♂; 27/7/10, GAW, CIW (on reverse). Called the Holotype by Waterhouse (1937), thereby designated as Lectotype "by inference of Holotype".

PARALECTOTYPE: 1 ♂ (QMT12430): Victoria/234.

CURRENT STATUS: Synonym of *Signeta flammeata* (Butler, 1882).

***Hesperilla croceus* Miskin, 1889c: 150 (130)**

Described from an unknown number of both sexes collected from Brisbane to Cooktown. Two specimens have been located.

LECTOTYPE: ♂ (QMT12431): G.J.M. Cooktown/130. Subsequently labelled: Misk. Type ♂; 27/7/10, GAW, CIW (on reverse)/ *Neohesperilla crocea* (Miskin). Called the Holotype by Waterhouse (1937), thereby designated as Lectotype "by inference of Holotype".

PARALECTOTYPE: 1 ♀ (QMT12432): 130. This specimen is probably from Brisbane.

CURRENT STATUS: *Neohesperilla crocea* (Miskin) (Lectotype) and synonym of *Neohesperilla xanthomera* (Meyrick & Lower, 1902) (Paralectotype).

***Hesperilla fulgidus* Miskin, 1889c: 151 (137)**

Described from (probably one) female (actually a male) collected at Brisbane, Qld. Not located although Waterhouse (1937) recorded it (then in QM) as the Holotype male, thereby designating it as Lectotype "by inference of Holotype". A female in QM labelled "Mackay/ 137" is mentioned in Miskin (1891) but not in the original description (Miskin 1889c) and is not a type. Waterhouse's 1910 notes list 3 further males which presumably were also added later.

CURRENT STATUS: Synonym of *Parnara amulia* (Semper, 1879).

***Hesperilla humilis* Miskin, 1889c: 150 (150)**

Described from an unknown number of both sexes collected at Brisbane, Qld. None located, although Waterhouse's 1910 notes list 2 males and 1 female. Waterhouse (1937) recorded the Holotype male (then in QM), thereby designating it as Lectotype "by inference of Holotype". It is number 150 in Miskin's notebook.

CURRENT STATUS: Synonym of *Toxidia parvula* (Plotz, 1884).

***Hesperilla senta* Miskin, 1891: 85**

Described from 1 female collected by C. J. Wild at Herberton, Qld.

HOLOTYPE: ♀ (QM12433): Herberton, ii, 1891, C. J. Wild/ *Hesperilla senta* Miskin. Subsequently labelled:

Misk. Type ♀; 27/7/10, GAW, CIW (on reverse)/ L/3016.

CURRENT STATUS: *Neohesperilla senta* (Miskin).

***Hesperilla tasmanicus* Miskin, 1889c: 149 (128)**

Described from an unknown number of "females" collected in Tasmania. Waterhouse's 1910 notes list 2 specimens; only a male (described as a female) has been located.

LECTOTYPE: ♂ (QMT12434): G.B. Tas[mania] [label torn off]/128. Subsequently labelled: Misk. Type ♀; 27/7/10, GAW, CIW (on reverse). Called Holotype by Waterhouse (1937), thereby designated Lectotype "by inference of Holotype".

CURRENT STATUS: *Pasma tasmanica* (Miskin).

***Pamphila albifascia* Miskin, 1889c: 148 (43)**

Described from (probably one) male collected at Herbert River, Qld. Waterhouse's 1910 notes indicate that this species was evidently added at a late stage to the Miskin Collection, being placed early in the notebook to fill a vacant number. Miskin (1891) placed this species as a synonym of *Carystus caesina* Hewitson.

LECTOTYPE: ♂ (QMT12435): Herbert R./43. Subsequently labelled: Misk. Type ♂; 27/7/10, GAW, CIW (on reverse). Called Holotype by Waterhouse (1937), thereby designated as Lectotype "by inference of Holotype".

CURRENT STATUS: *Sabera caesina albifascia* (Miskin).

***Pamphila autoleon* Miskin, 1889c: 147 (226)**

Described from an unknown number of "males" in the Miskin Collection and females in the Lucas Collection, both collected at Cardwell, Qld. Waterhouse's 1910 notes list 2 females from Cardwell, 7/84, in the Miskin Collection; only one (described as a male) has been located.

LECTOTYPE: ♀ (QMT12436): Cardwell/ 226. Subsequently labelled: Misk. Type ♂ = ♀; 27/7/10, GAW, CIW (on reverse). Called Holotype by Waterhouse (1937), thereby designated as Lectotype "by inference of Holotype".

CURRENT STATUS: *Sahera dobboe autoleon* (Miskin).

***Pamphila fuliginosa* Miskin, 1889c: 147 (197)**

Described from an unknown number of females collected at Cardwell, Qld. Waterhouse's 1910 notes list 2 females from Cardwell; only 1 has been located. The male was described subsequently by Miskin (1891: 76) from Cairns.

LECTOTYPE: ♀ (QMT12437): D.M.B. Cardwell/ 197. Subsequently labelled: Misk. Type ♀; 27/7/10, GAW,

CJW (on reverse). Called Holotype by Waterhouse (1937), thereby designated as Lectotype "by inference of Holotype".

CURRENT STATUS: *Sabera fuliginosa* (Miskin).

Tagiades gamelia Miskin, 1889c:146 (127)

Described from an unknown number of both sexes collected at Cape York, Qld. Three specimens have been located.

LECTOTYPE: ♂ (QMT12438): Cape York/127. Subsequently labelled: Misk, Type ♂; 27/7/10, GAW, CJW (on reverse)/ L/3015. Called Holotype by Waterhouse (1937), thereby designated as Lectotype "by inference of Holotype".

PARALECTOTYPES: 1 ♀ (QMT12439): Cape York/127. Subsequently labelled: Misk, Type ♀; 27/7/10, GAW, CJW (on reverse)/ L/3015. 1 ♀ (QMT12440): Cape York.

CURRENT STATUS: Synonym of *Tagiades japyx* *janetta* Butler, 1870.

Trapezites idothea Miskin, 1889c:152

Described from 1 specimen from Victoria in the Lucas Collection. The Holotype female is deposited in the South Australian Museum (Waterhouse 1933, 1937).

CURRENT STATUS: *Hesperilla idothea* (Miskin).

Trapezites philyra Miskin, 1889c: 153.

Described from an unknown number of both sexes from Victoria in the Lucas Collection. Waterhouse (1937) recorded the Holotype male at the South Australian Museum, thereby designating the Lectotype "by inference of Holotype".

CURRENT STATUS: Synonym of *Trapezites phigalia* (Hewitson, 1868).

ACKNOWLEDGEMENTS

I wish to thank G. B. Monteith and G. Thompson (Queensland Museum) for their assistance with this study and access to specimens, and E. D. Edwards (ANIC) for the loan of G. A. Waterhouse's unpublished notes on the Miskin Collection.

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EFFECTS OF PRESCRIBED BURNING ON HERPTILES IN SOUTHEASTERN QUEENSLAND

DAVID S. HANNAH AND GEOFFREY C. SMITH

Hannah D.S. & Smith, G.C. 1995 12 01: The effects of prescribed burning on herptiles in southeastern Queensland. *Memoirs of the Queensland Museum* 38(2):529-531. Brisbane. ISSN 0079-8835.

Study of herptile faunas within native forests and managed exotic pine plantations, subject to different burning regimes, produced inconsistent results with respect to the effects of fire management on vertebrate diversity and species richness. Abundance varied markedly among burning regimes in native forest areas (SPA1). □ *Herptiles, diversity, burning, species richness.*

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Information on the long term effects of repeated fires on fauna appears to be scant (Christensen & Abbott, 1989). There are few studies on the effects of fire on reptiles (Lunney et al., 1991) and fewer on amphibians (Bamford, 1992). The Beerburum Plantation Complex (centred on Beerburum Forestry Office: 26° 57' S, 152° 57' E), some 50 km north of Brisbane, incorporates relatively undisturbed native forest and managed plantations of exotic pine. These have mainly been burnt at 2-3 year intervals. There has been, however, no assessment of the impact of this or any other fire management regime on the fauna of these forests.

This study aimed to provide information on the diversity and density of herptiles in forests subject to different burning regimes. The native vegetation study was located in Scientific Purpose Area 1 (SPA1). Vegetation types in the SPA1 include heath, herblands, shrublands, and Scribbly Gum/Bloodwood associations. Fire treatment plots consisted of a control (unburnt since 1973), plots burnt during autumn-winter on a 3 year cycle (last burned 1991) and during winter-spring on a 5 year cycle (last burned 1993). Each plot was approximately 1.5 ha, with two replicate plots per treatment. Data from these replicates were pooled. The plantation study was located in the Twins Plantation Area (TPA), established in 1947-49 with *Pinus elliotii*, *P. caribaea* var. *hondurensis*, hybrids of these species, and remnant riparian and swamp vegetation. Treatments were located in three separate compartments: a control (unburnt since establishment) and two treatments (without fire for 7 years and without fire for 2 years). There was no regular burning, as per the SPA1. Compartments averaged 25ha in

area; systematic sampling targeted three 1ha quadrats per compartment/treatment.

Systematic sampling involved pitfall trapping with drift fences and active searching. Five pitfall traps, 400 mm deep by 240mm diameter, placed at five metre intervals, connected by a 300mm high aluminium fly wire drift fence, formed a pitfall line. There were 6 and 3 pitfall lines per treatment in the SPA1 and TPA, respectively. The SPA1 plots were surveyed over 6 consecutive days each (11-28 January 1994) and the TPA over 5 consecutive days each (24 March-20 April 1994). There were 180 and 75 pitfall trapping nights of effort per treatment in the SPA1 and TPA, respectively. A Diversity Index (Shannon & Weaver, 1949) was calculated for each treatment based on pit trapping data. Study areas were also actively and systematically searched. Incidental records were made in and around the study areas.

Systematic pit trapping and active searches recorded 133 individuals of 11 species of reptiles and 263 individuals of 4 species of amphibians in the SPA1, and 54 individuals of 9 species of reptiles and 124 individuals of 9 species of amphibians in the TPA (Table 1). Identifications were made by DH. With the exception of *Rhinoplocephalus boschmai* cf. and *Litoria brevipalmata*, the species recorded were typical for forests of the region. The *Rhinoplocephalus* spp. was uncharacteristic of *R. nigrescens* and was recorded as *R. boschmai*. *L. brevipalmata* was unexpected from the pine plantation; but the specimens caught and released in the TPA, conformed fully with the description by Cogger (1992). Specimens from the same locality have since been identified by G. Ingram (Qld Museum, pers. comm.). *L. brevipalmata* is listed as rare in Queensland (QDEH, 1993) along with *Crinia tinnula*, the most commonly caught species in the

TABLE 1.

Species	Native Vegetation				Pine Plantation			
	Unburnt	3 yr burn	5 yr burn	Incidental	Unburnt	2 yrs no fire	7 yrs no fire	Incidental
REPTILES								
Agamidae								
<i>Amphibolurus nobbi</i>	1	2	1					
<i>Diporiphora australis</i>		2(1)	1(5)					
<i>Pogona barbata</i>					-(1)	-(1)		
<i>Varanus varius</i>			-(1)					
Scincidae								
<i>Calypotus scutirostrum</i>							1	
<i>Cryptoblepharus virgatus</i>	-(2)	-(2)	-(4)		-(3)			
<i>Ctenotus arcanus</i>	-	1(1)	3(1)					
<i>Eulampris tenuis</i>				Present				
<i>Haemisphaeriodon gerrardi</i>	2	-(1)						
<i>Lampropholis amicula</i>					4		1	
<i>Lampropholis delicata</i>	14(11)	9(19)	7(38)		2(20)	-(3)	5(9)	
<i>Lygisaurus foliorum</i>		1						
<i>Tiliqua scincoides</i>	1							
Colubridae								
<i>Dendrelaphis punctulata</i>						-(1)		
<i>Tropidonophis mairii</i>				Present				Present
Elapidae								
<i>Demansia psammophis</i>		1			-(1)			
<i>Hemiaspis signata</i>	-(1)				-(1)			
<i>Rhinoplocephalus boschmai</i>				Present				
<i>Rhinoplocephalus nigrescens</i>					-(1)			
Pygopodidae								
<i>Lialis burtonis</i>								Present
AMPHIBIANS								
Myobatrachidae								
<i>Adelotus brevis</i>						1	1	
<i>Crinia tinnula</i>	37(4)	38(14)	30(24)		1			
<i>Limnodynastes ornatus</i>					1			
<i>Limnodynastes peronii</i>		2(2)	-(9)		11	21	15	
<i>Limnodynastes terraereginae</i>	2(2)	5	4					
<i>Pseudophryne coriacea</i>					1	1	2	
Hylidae								
<i>Litoria brevipalmata</i>					-(2)	-(3)	8	
<i>Litoria caerulea</i>				Present				
<i>Litoria fallax</i>				Present				Present
<i>Litoria latopalmata</i>						-(1)		
<i>Litoria nasuta</i>							-(2)	
Bufo								
<i>Bufo marinus</i>	4(2)	18(6)	47(13)		22(1)	11(10)	9	
TOTAL NUMBERS	61(22)	79(46)	93(95)		42(30)	34(19)	42(11)	
NUMBER OF SPECIES	9	12	10	5	13	9	9	3
SHANNON INDEX	1.18	1.56	1.25		1.91	1.26	2.42	

SPA1. The introduced *Bufo marinus* was common in both study areas. It associated significantly with the treatment burned every 5 years (fired 6 months previously) and avoided the control ($X^2=41.8$, $df=2$, $P<0.05$) in the SPA1. In contrast, it associated significantly with the control in the TPA ($X^2=7.0$, $df=2$, $P<0.05$).

The treatment burnt every 3 years (fired two and a half years previously) within the SPA1 and the treatment without fire for 7 years in the TPA yielded the highest Diversity Indices. The 3 year burnt treatment within the SPA1 and the control within the TPA returned the highest species numbers (pit-trapping and searching combined); there were no significant differences among treatments within either the SPA1 or TPA. The study suggests that fire management does not consistently affect diversity and species richness of herptiles. However, abundance did vary markedly among burning regimes in the SPA1 ($X^2=42.3$, $df=2$, $P<0.05$), with more than expected numbers occurring within the treatment burnt every 5 years (fired 6 months previously) and fewer in the unburnt control; differences were partly explained by *B. marinus* captures, but also *Lampropholis delicata* captures.

The numbers of species (excluding incidental records) were comparable between the SPA1 and TPA (15 and 18 respectively), despite differences in trapping and searching effort. Nevertheless,

species composition was different in the pine plantation compared to native vegetation.

ACKNOWLEDGEMENTS

Thanks to Glenda Head and Peter Schellenberger for logistical support; to Patrick Couper, Glen Ingram and Greg Czechura for assistance with identification. This project was supported by the DPI Forest Service.

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TABLE 1. Numbers of herptiles captured in pitfall traps and by active searching (in parentheses) in control and fire treatments in SPA1 and TPA. Other incidental records are provided for each study area. Shannon index for pit trapping only.

RECORD OF THE SCORPION *LIOCHELES KARSCHII* (KEYSERLING, 1855) FROM NORTH EAST QUEENSLAND (SCORPIONIDA: ISCHNURIDAE). *Memoirs of the Queensland Museum* 38(2):532. 1995:- The ischnurid scorpion *Liocheles karschii* (Keyserling, 1855) is known from New Guinea and adjacent islands. In Australia the species is reported only from islands of Torres Strait (Koch, 1977), but in December 1990 many specimens were observed in boulder caves in Black Mountain, 20km S of Cooktown, NE Queensland. A female specimen was collected from the Black Mountain caves and has been deposited in the Museum of Tropical Queensland, Townsville QMS105138).

Liocheles karschii is distinguished from other species of *Liocheles* in Australia by the large adult size (carapace length greater than 13.6mm) and the presence of a smooth continuous groove on the manus of the pedipalp in which trichobothria *dst*, *dsb* and *db* occur (Koch, 1977).

Liocheles karschii is not a troglobite, although it was abundant in the caves in Black Mountain. This species has been collected under logs in New Guinea (Koch, 1977), and may be found in the woodlands surrounding Black Mountain, although this habitat has not yet been investigated. Black

Mountain is constructed of granite boulders and its caves are interconnected gaps between the boulders. Unlike solution caves and lava tubes in which entry and egress is limited to one or a few points, the Black Mountain boulder caves are accessible at many points. Numerous other arthropods including opiliones, archaeognathids and centipedes were also observed in these caves.

This record extends the known range of *Liocheles karschii* by approximately 600km, and confirms the presence of this species in mainland Australia.

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BRYOZOA FROM HERON ISLAND, GREAT BARRIER REEF. 2

P.J. HAYWARD & J.S. RYLAND

Hayward, P.J. & Ryland, J.S. 1995 12 01: Bryozoa from Heron Island, Great Barrier Reef. 2. *Memoirs of the Queensland Museum*. 38(2):533-573. Brisbane. ISSN 0079-8835.

Forty-six species of Bryozoa are reported from shallow reef habitats of Heron Island, Queensland. Twenty new species are described: *Chaperiopsis harmeri*, *Beania pectinata*, *Thairopora calcarata*, *Exechonella ampullacea*, *Celleporaria hesperopacifica*, *C. sicaria*, *Calypthotheca rupicola*, *Robertsonidra praecipua*, *Cheiloporina campanula*, *Stylopoma herodias*, *Nimba saxatilis*, *Cigclisula fruticosa*, *Smittoidea incucula*, *Pleurocodonellina laciniosa*, *Fenestrulina epiphytica*, *Celleporina bellatula*, *C. cochlearia*, *C. fistulata*, *Iodictyum mamillatum* and *I. receptaculum*. Five species are reported for the first time from Australian waters. □ *Heron Island, Great Barrier Reef, Bryozoa, taxonomy.*

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Tropical bryozoan faunas are rich in species but poorly known taxonomically. Current knowledge is still largely founded on a very few monographic accounts (e.g., Canu & Bassler, 1929; Harmer, 1915, 1926, 1934, 1957), the usefulness of which is limited by the vast geographical areas they cover, and by their outdated and conservative taxonomy. Bryozoans are especially abundant in coral reef communities where they are an important part of cryptic, sessile faunas. Yet, as Winston (1986) showed, a century of ecological research into reef-associated faunas resulted in a world-wide checklist of just 284 species of Bryozoa. It had been assumed that bryozoans were of little consequence in reef ecosystems, largely through unfortunately biased collecting (Winston, 1986), and it was not until reef ecologists began to examine sessile reef communities that their true significance began to be revealed (e.g., Jackson & Winston, 1982). Faunistic studies of limited areas of reef (e.g., Hayward, 1988), and systematic revision of selected genera in limited geographical areas (e.g., Soule & Soule, 1973) continue to emphasize the abundance and taxonomic variety of coral reef-associated Bryozoa, and the present inadequate level of systematic study devoted to them. The bryozoan fauna of the Great Barrier Reef is especially rich. It certainly exceeds several hundred species, but the total cannot be estimated. In the first account of the bryozoan fauna of Heron Island reef flat (Ryland & Hayward, 1992), 81 species were described, of which 24 were recorded for the first time from Australian waters and 14 were new. A further 43 species are described and illustrated in this paper, together with three others noted or incorrectly identified in the previous paper (Ry-

land & Hayward, 1992). Of this total, 20 are new to science, while another five are reported for the first time from Australia.

A general account of Heron Island reef and the collecting sites worked were given in the first paper, together with details of 14 of the 28 stations sampled in 1972 and the occurrence of *Sargassum* sp. in 1988. Notes on the remaining 1972 stations, and on a further group of stations worked in 1988 are given in Appendix 1. All collecting sites are mapped in Fig. 1.

SYSTEMATICS

The taxonomic order adopted here follows that advocated by Gordon (1984, 1986, 1989a). Taxonomic diagnoses are presented at family and genus level, except where these have already been provided in the previous account (Ryland & Hayward, 1992). Species descriptions and measurements are based on Heron Island specimens. The synonymies given for each species are deliberately selective, and unverified synonyms have been excluded.

Class STENOLAEMATA Borg, 1926
Order CYCLOSTOMATIDA Busk, 1852a
Family FILISPARSIDAE Borg, 1944

DIAGNOSIS

Colony erect, branching, with flattened branches. Autozooids arranged in quincunx, or in transverse rows. Gonozooid frontal, partially immersed, often indistinct.

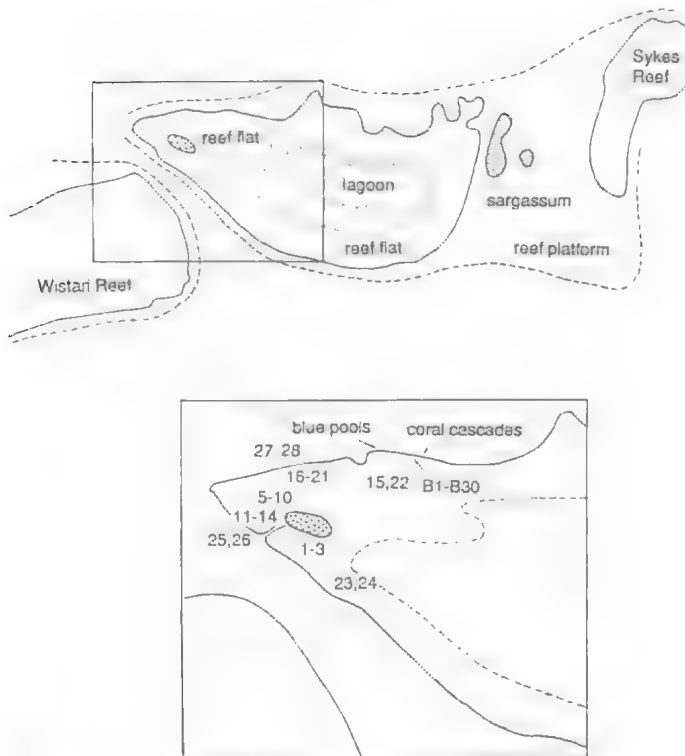


FIG. 1. Heron Island and reef, showing location of samples.

Nevianopora Borg, 1944

TYPE SPECIES

Idmonea milneana d'Orbigny, 1839.

DIAGNOSIS

Colony erect, branching dichotomously, with flat basal surfaces. Autozoooid orifices in regular transverse rows, the median one slightly more proximally situated than those on either side. Gonozoooid frontally situated at a branch dichotomy, irregular in outline, the oeciostome shortly tubular and flared.

**Nevianipora pulcherrima (Kirkpatrick)
(Fig. 2A)**

Idmonea pulcherrima Kirkpatrick, 1890a: 22, pl. 4, fig. 6.

Tubulipora pulcherrima (Kirkpatrick) Harmer, 1915: 129, pl. 9, figs. 1-5.

Nevianopora pulcherrima (Kirkpatrick) Brood, 1976: 292, fig. 12H,L.

MATERIAL EXAMINED

Stn. 27.

REMARKS

A single colony was collected from Stn. 27, encrusting *Iodictyum receptaculum* sp. nov.

DISTRIBUTION

Described originally from the Torres Straits, *N. pulcherrima* is widely distributed through the Indo-Malayan region, and westwards to the coasts of East Africa. It will probably prove to be common throughout the northern GBR province.

Family LICHENOPORIDAE

Smitt, 1867

Disporella Gray, 1848

TYPE SPECIES

Discapora hispida Fleming, 1828.

DIAGNOSIS

Colony encrusting, discoidal or cup-shaped, with a thin peripheral lamina. Autozoooids in radiating or quincuncial series; linked by calcified struts defining alveoli, extra-zoooidal coelomic spaces. Alveoli progressively reduced by centripetal calcification but not closing completely, retaining a central foramen. Embryos brooded in extra-zoooidal brood chambers in the central region of the colony; embryos released through a short, tubular, upwards-directed oeciostome.

**Disporella buski (Harmer)
(Fig. 2B-D)**

Lichenopora buski Harmer, 1915: 161, pl. 12, figs 4,5.

Disporella buski (Harmer) Brood, 1976: 299, figs 17D-G.

DESCRIPTION

Colonies circular, developing a deep cup-shape, up to 3.5mm diameter. First three or four astogenetic generations of autozoooids ordered in radiating linear series; thereafter diverging and adopting a regular quincuncial arrangement. Autozoooid tubes more or less oval in section, to 0.08mm wide; especially long in deepest part of cup, the distal lip drawn out into two or three slender, spinous processes. Short spines also

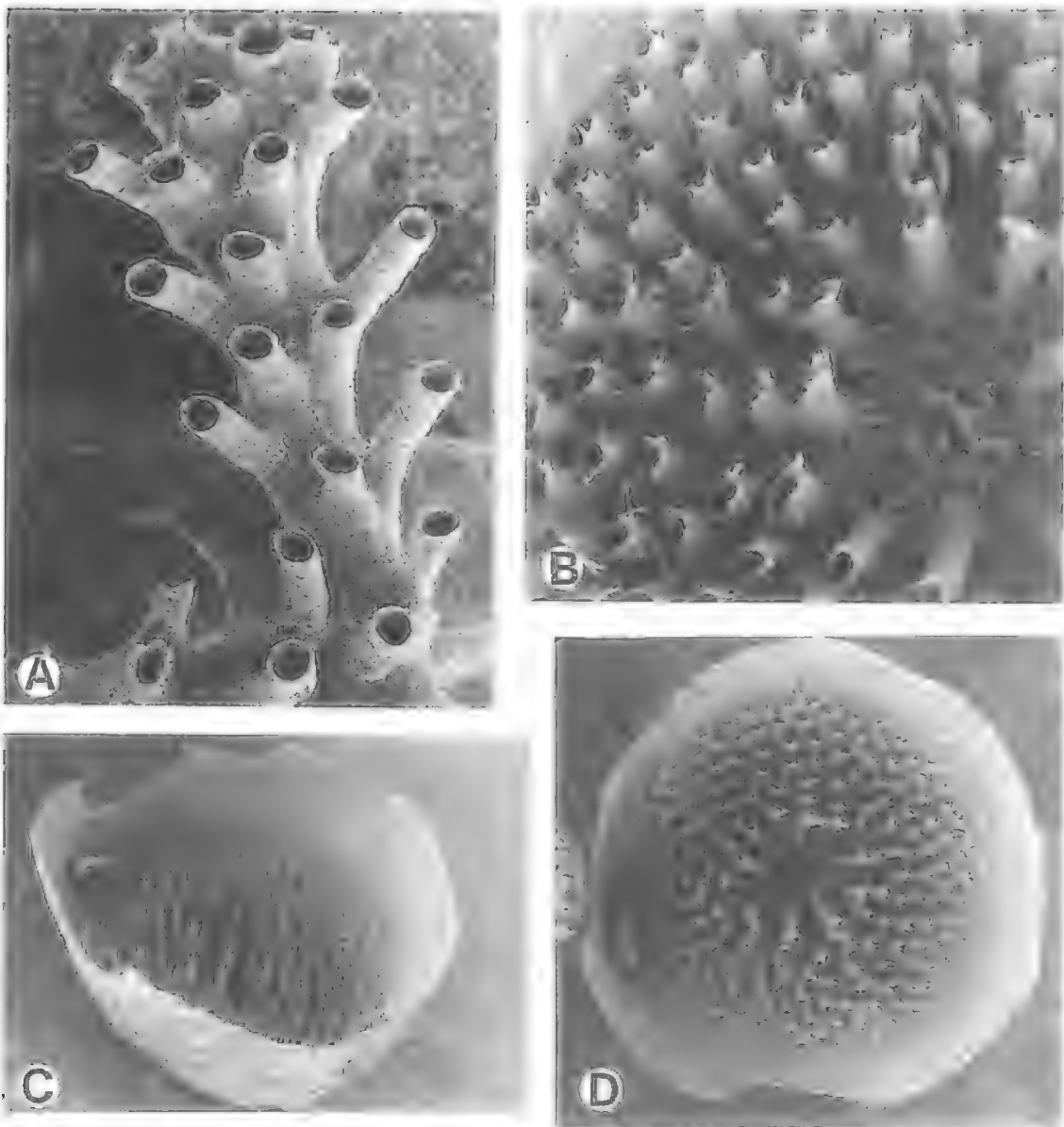


FIG. 2. A, *Nevianipora pulcherrima*, x34. B-D, *Disporella buski*. B, part of colony, with ooeciostome, x40. C, entire colony in oblique lateral view, x14. D, entire colony viewed from above, x15.

present on the upper surface of the autozoid tube. Brood chamber apparent as a finely perforated sheet underlying calcified struts linking the bases of the central autozoid tubes; ooeciostome short, round-sectioned, its aperture level with the surface of the chamber.

REMARKS

Numerous cup-shaped colonies of this species were present on *Sargassum*, sometimes closely intergrown with encrusting cheilostomates. The spinous peristomes and the finely perforated brood chamber are characteristic for *D. buski*, as is the short, round-sectioned ooeciostome.

DISTRIBUTION

Described originally from the Indo-Malayan region, *D. buski* is widely distributed in the western Pacific, from New South Wales to Japan, and has been recorded from a dozen localities on the East African coast (Brood, 1976). It is common in the Torres Straits, and probably throughout the GBR province.

Family CRISIIDAE Johnston, 1838

DIAGNOSIS

Colony erect, branching, jointed; each internode of one to many tubular autozooids, all frontally facing, linked by chitinous, tubular nodes. Gonozooid inflated, replacing an autozooid, with densely punctate calcification; oöciostome distally situated, slit-like, tubular or flared.

Crisia Lamouroux, 1812

DIAGNOSIS

Sterile internodes consist of at least three, to more than 30 autozooids; fertile internodes (bearing gonozooids) with at least five autozooids. Basally jointed spines present in many species.

TYPE SPECIES

Sertularia eburnea Linnaeus, 1758.

Crisia elongata Milne Edwards
(Fig. 3A)

Crisia elongata Milne Edwards, 1838: 203.

Crisia elongata Milne Edwards, Harmer, 1915: 96, pl. 8, figs 1-8; Gordon, 1989b: 448, figs 1, 2.

REMARKS

This widely distributed tropical crisiid is recognized by its curled branches, black joints, and broad, globular gonozooid, which has a narrow, slit-like oöciostome. It has been widely recorded from reef habitats in the Indo-West Pacific region, as well as from Samoa, and East Africa. Several colonies were found attached to *Sargassum* leaflets.

Bicrisia sp.
(Fig. 3B)

REMARKS

Several small colonies of *Bicrisia* were present in the sample of *Sargassum*. Unfortunately, none bore gonozooids, without which the species' identity cannot be established.

Class GYMNOLAEMATA Allman, 1856
Order CHEILOSTOMATIDA Busk, 1852a
Suborder INOVICELLINA Jullien, 1888
Superfamily AETEOIDEA Smitt, 1867
Family AETEIDAE Smitt, 1867

DIAGNOSIS

Colony encrusting, creeping; consisting of tubular autozooids, each with a decumbent proximal portion, and an erect tubular portion bearing distally the frontal membrane and operculum. The adherent proximal portions constitute a ramifying, stolon-like growth, filiform or moniliform. The polypide occupies the whole of the autozooid, and may be withdrawn into the encrusting, proximal part. The everted tentacle sheath has a finely toothed collar. Embryos brooded in membranous, evanescent ovisacs, attached at the distal end of the autozooid.

Aetea Lamouroux, 1812

TYPE SPECIES

Sertularia anguina Linnaeus, 1758.

DIAGNOSIS

As for family.

Aetea anguina (Linnaeus)
(Fig. 3D)

Sertularia anguina Linnaeus, 1758: 816.

Aetea anguina (Linnaeus) Harmer, 1926: 194, pl. 13, figs. 3, 4; Ryland & Hayward, 1977: 45, fig. 13.

REMARKS

Dense colonies of this species were abundant on *Sargassum*, while more diffuse and smaller colonies occurred in the interstices of coral rubble. *Aetea anguina* appears to have a worldwide distribution, except for polar seas. It is distinguished from other species of the genus by its variably flexed, spatulate distal end. The Heron Island specimens differed from European specimens in displaying variation in the length of the closely ringed erect portion of the autozooid, below the frontal membrane. This varied by as much as 100% among autozooids of a single colony. The shorter individuals, with reflexed, spatulate distal ends could not be distinguished from European *A. anguina*. Species of *Aetea* are probably common in cryptic reef environments, but their delicate colonies are usually damaged beyond identification by collection.

Suborder MALACOSTEGINA Levinsen, 1909
 Superfamily MEMBRANIPOROIDEA
 Busk, 1854
 Family MEMBRANIPORIDAE Busk, 1854

DIAGNOSIS

Colony an encrusting, unilaminar sheet; in some species developing erect, foliaceous, bilaminar sheets from an encrusting base. Autozooids lightly calcified, with little or no gymnocystal calcification; the frontal surface almost entirely membranous. A small area of cryptocystal calcification present below the membrane in some species. Tubercles typically present at the proximo-lateral corners of autozooids, often well developed; small marginal spinules may border the opesia. No avicularia or ovicells. Interzooidal communication achieved via multiporous septula. Larva a planktotrophic cyphonautes.

Membranipora de Blainville, 1830

TYPE SPECIES

Flustra membranacea Linnaeus, 1767.

DIAGNOSIS

Characters of the family. Most species are epiphytic. The larva gives rise to a twinned ancestrular zooid.

Membranipora tuberculata (Bosc)
 (Fig. 3C)

Flustra tuberculata Bosc, 1802: 118.

Membranipora tuberculata (Bosc) Osburn, 1950: 23, pl. 2, figs 4-6; Mawatari, 1974: 23, fig. 2; pl. 2, figs 1-4.

REMARKS

Small colonies of this species were common on *Sargassum* sp. At the growing edge the plate-like gymnocyst of developing autozooids could be seen enrolling on each side to form the rounded tubercles characteristic of later ontogeny, in the manner described and figured by Osburn (1950) and Mawatari (1974). The narrow cryptocyst bore a few marginal spinules in some autozooids.

DISTRIBUTION

M. tuberculata is "found wherever *Sargassum* drifts over the warmer seas..." (Osburn, 1950). It has not been previously noted from Australia, but is certainly common throughout the western Pacific.

Family ELECTRIDAE Stach, 1937

Colony encrusting, forming a unilaminar sheet; or developing erect, bilaminar lobes or sheets from an encrusting base. Autozooids with well developed gymnocyst, perforate or imperforate, but only a minimal development of the cryptocyst. Spines generally present, though sometimes reduced: a single medio-proximal spine, often very long, occurs in almost all species; additional marginal spines bordering the opesia variably developed. No avicularia or ovicells. Interzooidal communication via multiporous septula. Larva a planktotrophic cyphonautes, giving rise to a single ancestrular zooid.

Electra Lamouroux, 1816

TYPE SPECIES

Flustra pilosa Linnaeus, 1767.

DIAGNOSIS

As for family.

Electra bellula (Hincks)
 (Fig. 4A)

Membranipora bellula Hincks 1881, 149, pl. 8, figs 4, 4a, 4b.

Electra bellula (Hincks) Cook 1985, 89.

REMARKS

Electra bellula does not seem to have been recorded again from Australia since Hincks' (1881) original account, although Livingstone (1927) regarded Haswell's (1881) *Membranipora cervicornis* as belonging to it. Hincks (1881) described the nominate species and var. *multicornis* from unknown Australian localities, and var. *bicornis* from Ceylon. He also recorded the nominate species from Madagascar, St. Vincent and the Cape Verde Islands. Hastings (1930) described and figured *Electra bellula* var. *bicornis* (Hincks) from the Galapagos Islands; Cook (1985) described West African specimens and reviewed the geographical distribution of the species.

The autozooids are 0.4-0.5mm long, with a smooth gymnocyst bearing medially a long, horny, basally pointed spine, characteristic of the genus. The oval opesia, which comprises half the total autozooid length has two to four flat, variably branched spines along its proximal edge, which are curved over the frontal membrane,

forming a closely reticulate shield. There are four or five thin, erect, reflected oral spines, and additional short, thin spines may occur elsewhere on the gymnocyst or along the margins of the autozoid. At Heron Island it occurred only on *Sargassum*, although Cook (1985) reported it encrusting hard substrata. Development of the overarched opesia spines varies between colonies and the varietal distinctions '*bicornis*' and '*multicornis*' are almost certainly without geographical or genetic justification.

Suborder NEOCHEILOSTOMINA

d'Hondt, 1985

Superfamily CALLOPOROIDEA

Norman, 1903

Family CALLOPORIDAE Norman, 1903

Parellisina albida (Hincks)

Membranipora albida Hincks, 1880: 81.

Parellisina albida (Hincks) Osburn, 1949: 4, fig. 8.

Parellisina curvirostris Ryland & Hayward, 1992: 229, fig. 2d.

REMARKS

This species was incorrectly identified as *P. curvirostris* (Hincks) by Ryland & Hayward (1992). *P. albida* is distinguished from *P. curvirostris* by its avicularium, the mandible of which has wide basal extensions, above which it abruptly narrows. It was common at Heron Island, occurring in nine samples.

DISTRIBUTION

Presently known only from an unrecorded Indo-Malayan locality ("Singapore or Philippines" (Hincks 1880)). The *P. albida* described and figured by Mawatari & Mawatari (1980) from Japanese localities has an extremely large avicularium chamber and the mandible lacks the latero-basal lobes of Hincks' species; it is almost certainly distinct from *P. albida* (Hincks). This is the first Australian record of the species.

Family CHAPERIIDAE Jullien, 1881

DIAGNOSIS

Colonies encrusting; or erect, foliaceous or branching. Autozooids with variably developed cryptocyst, opesia occupying one-fifth to two-thirds frontal length. No gymnocyst. Occlusor laminae - calcified struts marking position of opercular occlusor muscles - present within cav-

ity of zooid. Spines, ovicells and avicularia present or absent.

Chaperia Jullien, 1881

TYPE SPECIES

Flustra acanthina Lamouroux, 1825.

DIAGNOSIS

Colony encrusting. Autozooids with membranous frontal wall, partly underlain by a smooth or granular cryptocyst; opesia subcircular, occupying up to two-thirds frontal length. No gymnocyst. Obliquely orientated occlusor laminae present within opesia, extending from proximo-lateral corners to distal wall of autozoid. Spines present bordering the lateral and distal rim of the opesia. No avicularia. No ovicells. Multiporous septula present in vertical walls.

Chaperia sp.

(Fig. 5A)

MATERIAL EXAMINED

A single small colony on *Sargassum* sp.

REMARKS

This is possibly the same species as that recorded from various Indo-Malayan localities as *Chaperia acanthina* (Lamouroux), for example by Harmer (1926). *C. acanthina* is a southern hemisphere, cold temperate species, distributed from the Falkland Isles to Kerguelen and southern New Zealand (Gordon, 1986). It is characterized by a broadly oval, thick-rimmed opesia, constituting about half the total length of the autozoid, and a distal row of five to seven spines. Its occlusor laminae are long, and almost parallel to the disto-proximal axis of the autozoid, widely spaced where they intersect the distal wall. The Heron Island species has rather small autozooids, commonly 0.45 x 0.3mm, with an oval opesia occupying about two-thirds autozoid length. There are 10-13 distal spines, some borne on the rim of the opesia, and some issuing from the distal wall. It closely resembles the specimens figured by Harmer (1926, pl.14, figs. 9,10) and Scholz (1991) as *C. acanthina*. *Chaperia judex* (Kirkpatrick), recorded from Mauritius and the Philippines (Hayward, 1988) is another tropical species formerly confused with *C. acanthina*. It has 15 or more stout spines almost completely enclosing the opesia. The Heron Island material is insufficient to give a complete description of a new taxon; it is obvi-

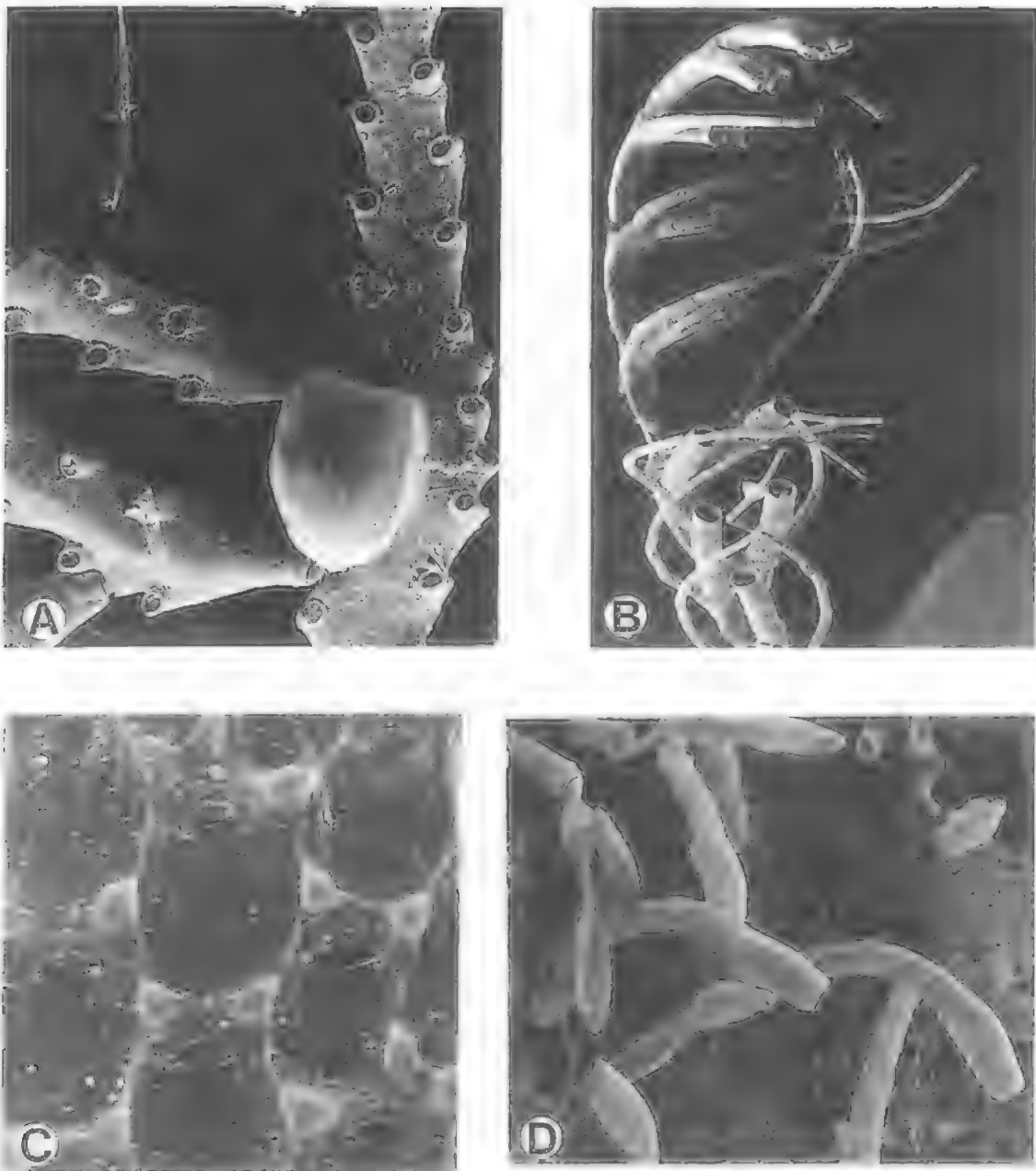


FIG. 3. A, *Crisia elongata*, x50. B, *Bicrisia* sp., x50. C, *Membranipora tuberculata*, x70. D, *Aetea anguina*, x70.

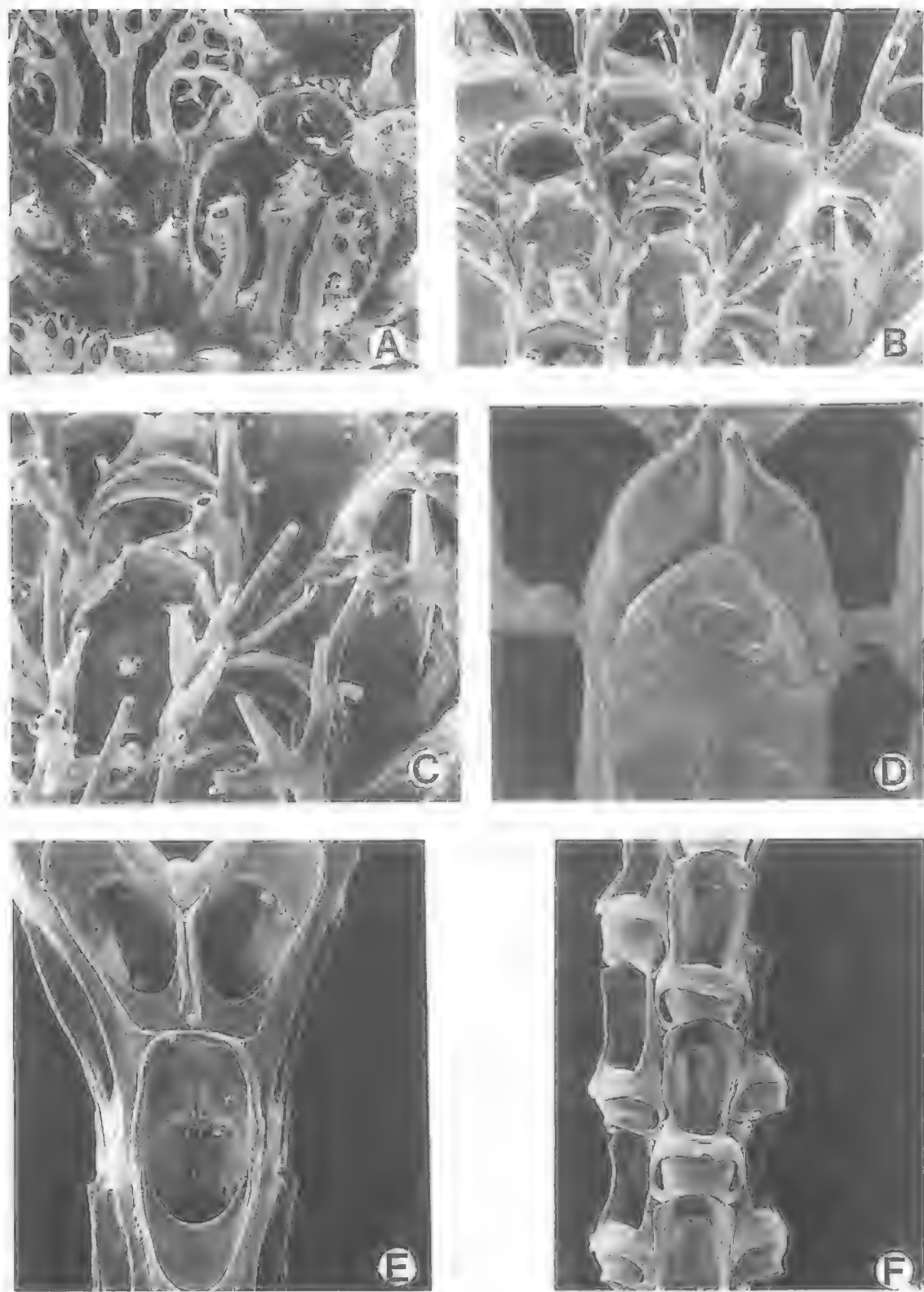
ously different from *C. acanthina*, but a formal description must await the discovery of further material.

***Chaperiopsis harmeri* sp.nov.**
(Fig. 4B,C)

Chaperia cervicornis: Harmer, 1926: 230, pl.14, fig. 8.

MATERIAL EXAMINED

HOLOTYPE: QMG304963, on *Sargassum* sp.



PARATYPES: QMG304968, on *Sargassum* sp.

DESCRIPTION

Colonies developing small, unilaminar patches. Autozooids oval, small, commonly 0.45 x 0.3mm, with an almost circular opesia comprising just less than half total length; proximal calcification thin and finely granular. There are four (rarely six) distal spines: proximal pair fairly stout, bifurcating three or four times to develop an open-branched antler shape, the tines cylindrical; distal pair shorter and thinner, bifurcated once or twice. At the growing edge some autozooids have a third pair of very thin spines projecting almost horizontally from the distal wall. Occlusor laminae very short, and indistinct; widely spread apart, passing between the bases of the proximal and distal spine on each side. Ovicell a shallow helmet shape, with a very large aperture, above this is a narrow, transverse frontal fenestra. The distal pair of spines curves along the sides of the ovicell. Avicularia rare, shortly columnar, present on the gymnocyst of autozooids succeeding an ovicell, projecting above the ovicell, with a short, proximally-directed mandible.

REMARKS

This is undoubtedly the species described and figured by Harmer (1926) as *C. cervicornis* (Busk). Gordon (1986) remarked that Harmer's specimens, from the Torres Straits, were probably distinct from *C. cervicornis*, which ranges from the Bass Strait and Tasmania, south to New Zealand, and west to the Magellan Strait. *C. cervicornis* has six to eight rather stout, cervicorn spines; the proximal pair are usually broadened with the tines flexed medially and meeting above the frontal membrane.

ETYMOLOGY

For S.F. Harmer.

Family QUADRICELLARIIDAE Gordon, 1984

Nellia Busk 1852a
Nellia simplex Busk
(Fig. 4E,F)

Salicornaria marginata Busk, 1852a: 367.

Nellia simplex Busk, 1852b: 19, pl. 65, fig. 1; pl. 65 (bis), fig. 3.

Acanthodesia simplex (Busk) Harmer, 1926: 220, pl. 13, fig. 23.

MATERIAL EXAMINED

Stns. 25b, 28.

DESCRIPTION

Colony a dense, bushy tuft, 55mm high, branching dichotomously at intervals of 1-4mm; attached by a thick bundle of tubular rhizoids. Branches square-sectioned, 0.3mm wide, consisting of four longitudinal autozooid series, in two back-to-back pairs. Joints flexible; dichotomies continuously calcified when first formed, but fracturing across base of each new ramus, the joints then formed from thick chitinous tubes. Autozooids oblong, 0.5-0.65 x 0.3mm; frontal surface largely membranous, bounded by narrow, smoothly calcified rim of lateral wall, and with a small, triangular area of gymnocystal calcification on each proximo-lateral corner. Cryptocyst smooth, imperforate, concave, underlying about one-third total length of frontal membrane; a similar-sized shelf of interior calcification occupies the distal third of the autozooid cavity, but at a lower, i.e., more basal, level than the cryptocyst. Latero-basal walls meet in a pronounced suture along the midline of the autozooid. Large, multiporous septula present on lateral walls. Ovicell distinctive, wider than long, smoothly calcified and imperforate; protruding into the cavity of the distally succeeding autozooid, the vertical, lateral walls of which enclose the ovicell on each side, and extend as narrow tongues across the distal edge of the ovicell, fusing and defining the opesia of the distal autozooid. Avicularia absent. Small, triangular foramina in one or both of the proximo-lateral corners of some autozooids mark the origins of the long, tubular rhizoids, which grow basally, closely applied to the surfaces of the branches, and gather to form the rooting bundle.

REMARKS

A single, large, profusely branched colony was collected from Stn. 25b, and several small colonies from Stn. 28. *Nellia simplex* was described from the Torres Straits by Busk (1852b) and listed by Kirkpatrick (1890b) in his report on the Torres

FIG. 4. A, *Electrabellula*, x160. B,C, *Chaperiopsis harmeri*; autozooids at the colony edge, x60. C, detail showing ovicells and an avicularium, x93. D, *Beania magellanica*, x110. E,F, *Nellia simplex*. E, autozooids at a branch dichotomy, x70. F, ovicelled autozooids, x40.

Straits collections made by A.C. Haddon in 1888-1889. Harmer (1926) founded his account on the fragmentary specimens described by these two authors, and the species does not seem to have been described subsequently.

Superfamily BUGULOIDEA Gray, 1848
Family BEANIIDAE Canu and Bassler, 1927

***Beania magellanica* (Busk)**
(Fig. 4D)

Diachoris magellanica Busk, 1852b: 54, pl. 67, figs 1-3.

Beania magellanica (Busk) Ryland & Hayward, 1992: 235.

REMARKS

This widely distributed species was described by Ryland & Hayward (1992) but not illustrated. The specimen figured here is part of a large colony from Station 23.

***Beania ?plurispinosa* Uttley & Bullivant**
(Fig. 5B)

Beania plurispinosa Uttley & Bullivant, 1972: 28.
Gordon, 1984: 46, pl. 12, figs A-C.

MATERIAL EXAMINED
Stn. 88 B1.

REMARKS

A single, minute specimen of an especially spiny *Beania* was collected at Stn. B1. The operculum and frontal membrane are bordered by very long, thin spines, and numerous similar spines cover the basal walls of the autozooids. The species is closely similar to the Kermadec Ridge specimen figured by Gordon (1984, pl. 12, fig. B), but the Heron Island specimen consisted of no more than 10 autozooids and a firm identification cannot be given.

***Beania pectinata* sp. nov.**
(Fig. 5C,D)

MATERIAL EXAMINED
HOLOTYPE: QMG304961, on *Sargassum* sp.

DESCRIPTION

Colony diffuse, consisting of tapered, fusiform autozooids, 0.6mm long, standing erect on an adherent stolon, 0.05mm wide, which comprises the proximal portions of the autozooid. Frontal

membrane of autozooid entirely concealed by an almost flat shield formed from two comb-like rows of lateral spines, touching but not fusing along the midline of the autozooid. Operculum terminal, as wide as long; four short, slender processes spaced around the orifice rim: two distal and two lateral. Basal wall of autozooid smooth; no avicularia. Each autozooid has four basal connecting tubes: its own proximal portion, a distal tube representing the proximal portion of the next autozooid, and a short tube on each side, either or both of which may develop into a lateral autozooid. Ovicells were not present.

REMARKS

The four basal connecting tubes, comb-like frontal shield, smooth basal wall and lack of avicularia together distinguish this species from all other described species of *Beania*.

ETYMOLOGY

Latin *pectinatus*, comblike.

***Beania klugei* Cook**
(Fig. 6A,B)

Beania klugei Cook, 1968: 164, figs 2A,B.

MATERIAL EXAMINED
Stn. 29.

DESCRIPTION

The colony forms diffuse, branching, uniserial chains of slender autozooids, creeping across the surface of coral rubble. Autozooids are 0.8-0.9 x about 0.25mm, more or less parallel-sided, but strongly tapered in the proximal one-fifth; the frontal surface is entirely membranous. Spines are lacking, except for a pair of short, pointed distal processes. Each zooid bears a pair of small pedunculate avicularia attached laterally adjacent to the operculum. New autozooids are budded from a single disto-basal septulum, and paired proximo-lateral septula. Ovicells were not present.

REMARKS

Beania klugei was described from West Africa (Cook, 1968) but shown to have a tropical/sub-tropical distribution extending west to Panama, and east to the Red Sea and Zanzibar. Cook (1985) discusses the probability of its wider occurrence in the Indian Ocean. This is the first record of the species for Australia, and the West Pacific region.

Superfamily MICROPOROIDEA Gray, 1848
Family ONYCHOCELLIDAE Jullien, 1882

DIAGNOSIS

Colony encrusting. Autozooids with an extensive cryptocyst, but no gymnocyst; opesia constituting half or less of total autozooid length. Distal edge of cryptocyst notched or indented to accommodate parietal and/or opercular muscles. Avicularia vicarious, with a large mandible consisting of a thick, longitudinal sclerite and single or paired lateral laminae. No spines. Embryos brooded internally, often in dimorphic female zooids.

Smittipora Jullien, 1882

TYPE SPECIES

Vincularia abyssicola Smitt, 1873.

DIAGNOSIS

Autozooid with an extensive opesia. Avicularian mandible symmetrical, with two equally developed lateral laminae.

Smittipora cordiformis Harmer
(Fig. 6C)

Smittipora cordiformis Harmer, 1926; 260, pl. 16, figs 14-18.

DESCRIPTION

Colony an encrusting, unilaminar sheet. Autozooids hexagonal to irregularly polygonal, concave, separated by distinct sutures; 0.5-0.6 x about 0.4mm. Frontal membrane light brown, distinct, underlain by a thick, finely granular cryptocyst; opesia longer than wide, 0.15 x 0.13mm, situated in distal half of autozooid, its proximal edge with an angular lip. Avicularia as long as autozooids but much narrower (0.2mm), the cryptocyst deeply concave; with an elongate oval opesia, distinctly broadened distally; distal end of avicularium narrowed and channelled for the reception of the rachis.

DISTRIBUTION

The single colony collected, at Stn. 9, marks the first record of this species from Australia. It was described by Harmer (1926) from two 'Siboga' stations in Indonesia, with additional material from Singapore, Burma and the Amirante Islands. D'Hondt (1986) recorded it from New Caledonia.

Family THALAMOPORELLIDAE
Levinsen, 1909

DIAGNOSIS

Colony encrusting or erect. Frontal membrane of autozooid entirely underlain by a granular, concave cryptocyst; opesia usually coincident with operculum; single or paired opesiules present, large. No gymnocyst. Avicularia vicarious. Ovicell large, bivalved; or absent. Vertical walls with multiporous septula. Calcareous spicules present in cavity of autozooid.

Thairopora MacGillivray, 1882

TYPE SPECIES

Membranipora dispar MacGillivray, 1869.

DIAGNOSIS

Colony encrusting, unilaminar. Frontal surface of autozooids almost entirely membranous, underlain by a complete, porous cryptocyst; opesia almost exactly coincident with operculum, with large, paired opesiules. Opesia longer than wide, oval or horseshoe-shaped, flanked by paired, hollow tubercles. Avicularia present, vicarious. Ovicells absent.

Thairopora calcarata sp. nov.
(Figs 6D-F, 7A)

MATERIAL EXAMINED

HOLOTYPE: G304962, on *Sargassum* sp.
PARATYPE: G304967, on *Sargassum* sp.

DESCRIPTION

Colonies developing irregular, unilaminar patches on *Sargassum* leaflets, adjacent lobes occasionally fusing to form short, erect, bilaminar plates. Autozooids more or less rectangular, in regular radiating rows which bifurcate at intervals; each new row commences with a vicarious avicularium. Vertical walls of autozooid form a thin, raised rim around the frontal membrane; beneath it the cryptocyst is flat to concave, and dips distally towards two large, irregularly oval, unequal-sized opesiules. Cryptocyst initially thin and smooth, with about 30 minute perforations; proximal end more distinctly nodular in later ontogeny. Opesia terminal, longer than wide, broadly oval; distal two-thirds with a smooth rim, terminating proximally, on each side, with a sharp, upturned condyle; proximal third with a broad rim of nodular, cryptocystal calcification. On each side of the operculum the

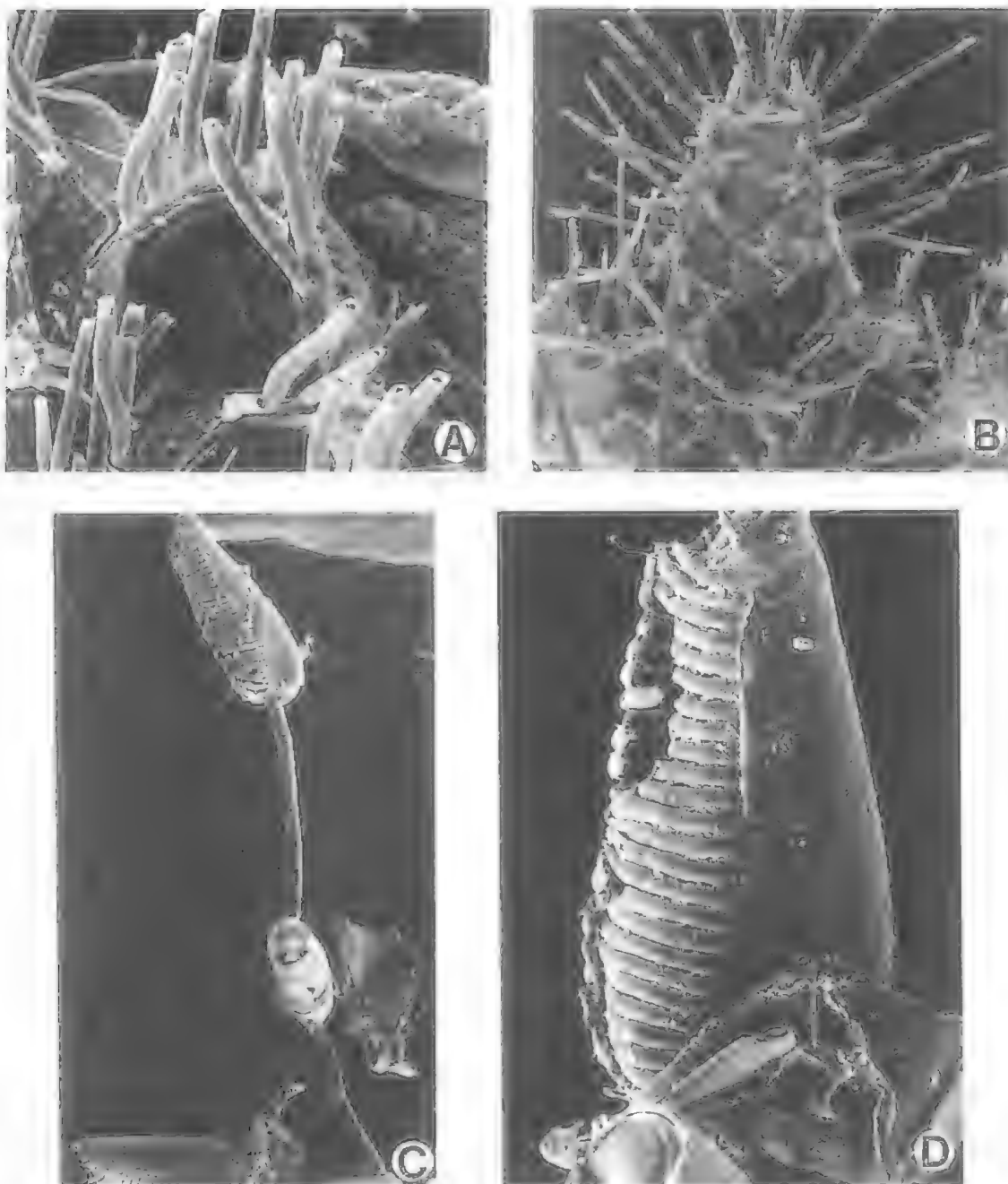


FIG. 5. A, *Chaperia* sp., x86. B, *Beania* ?*plurispinosa*, x80. C,D, *Beania pectinata*. C, part of colony, x50. D, detail of a single autozooid, x150.

smooth gymnocystal calcification constituting the distal opesial rim develops an erect tube, 0.4mm high, which expands and divides at its tip to form a branched, club-like process; these form a close lattice over the surface of the colony.

Avicularia about half as long as autozooids; rostrum smoothly calcified, in the form of a rounded, parallel-sided hood, projecting almost perpendicularly from frontal plane of zooids; proximal half with a narrow band of cryptocyst underlying the

frontal membrane; mandible elongate oval, with elongate sclerites converging at its rounded distal end. Three types of spicule present: bow-shaped compasses of two sizes (0.04mm, 0.08mm), and very long, almost straight calipers (0.19mm).

Measurements (means and standard deviations of 20 values, mm): autozoid length 0.55 ± 0.05 ; width 0.28 ± 0.03 .

REMARKS

Thairopora calcarata is distinguished from other species of the genus by the paired, branched processes flanking the zoid opesia. These interlace above the colony surface forming a regular, reticulate structure, with the meshes situated immediately above the opercula, presumably allowing lophophores to project through them. Numerous colonies were found on *Sargassum* leaflets; the epiphytic habit is characteristic of the genus.

ETYMOLOGY

Latin, *calcaris*, a spur.

Superfamily CELLARIOIDEA Fleming, 1828
Family CELLARIIDAE Fleming, 1828

DIAGNOSIS

Colony erect, branching, jointed or unjointed, attached by chitinous, tubular rhizoids. Branches cylindrical or flat-sectioned, dividing dichotomously, and/or producing lateral adventitious shoots. Autozooids in alternating, longitudinal series, in whorls around branch axis; gymnocyst absent, cryptocyst extensive, opesia coincident with operculum. Avicularia present or absent. Ovicells immersed (endotoichal).

Cellaria Ellis and Solander, 1786

TYPE SPECIES

Farcimia sinuosa Hassall, 1840.

DIAGNOSIS

Branches cylindrical, dividing dichotomously at regular intervals, and sometimes producing additional, adventitious branches. Each branch (internode) originating from a chitinous joint (node). Autozooids typically hexagonal or diamond-shaped. Opesia scarcely larger than operculum; condyles usually present within straight or convex proximal lip. Avicularia vicarious, intercalated within an autozoid row and small, or entirely replacing an autozoid. Ovicell with independent aperture distal to opesia.

Cellaria punctata (Busk) (Fig. 7D)

Salicornaria punctata Busk, 1852a: 366 (in part).

Salicornaria gracilis Busk, 1852b: 17, pl. 63, fig. 3; pl. 65 bis, fig. 2.

Cellaria punctata (Busk) Harmer, 1926: 337, pl. 21, figs 14-16; text-fig. 13a.

MATERIAL

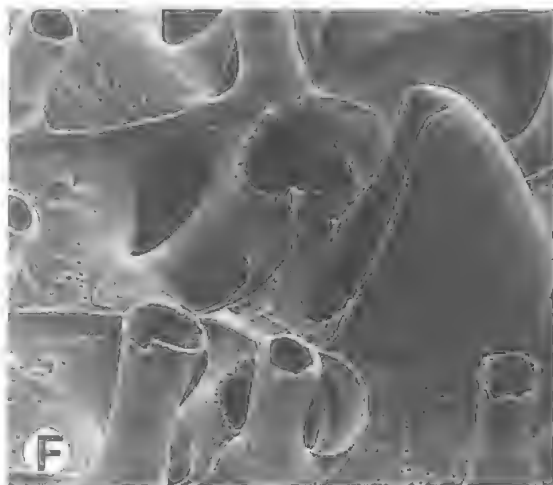
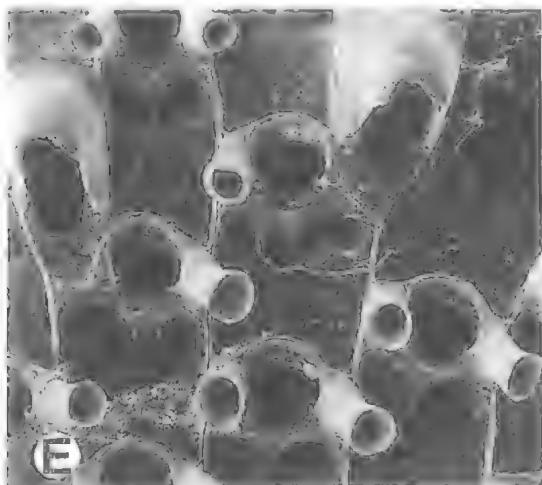
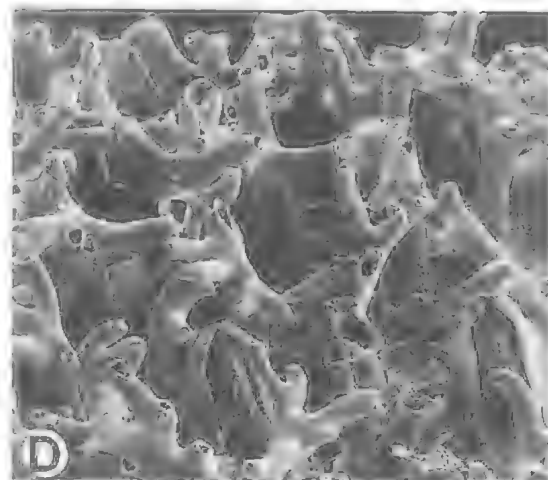
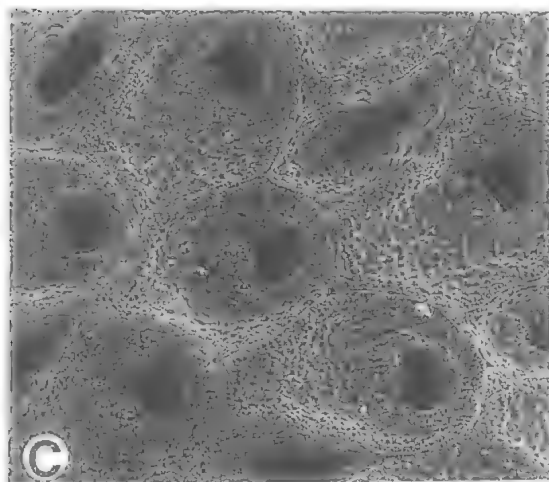
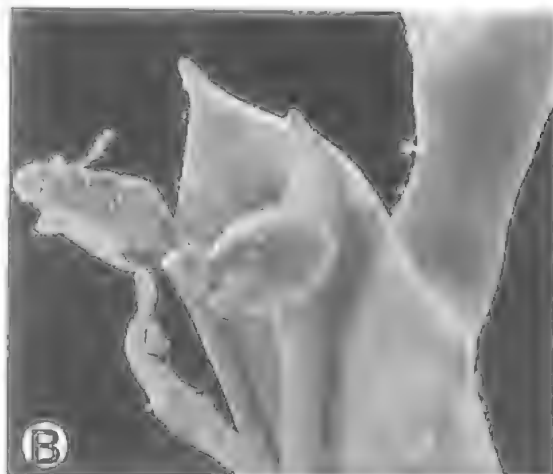
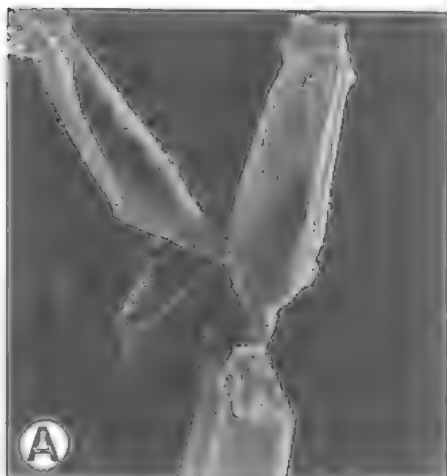
Stn. 28; one small colony attached to *Pleurotoichus clathratus*.

DESCRIPTION

Internodes slender, to 2.5mm long in the present specimen; diameter 0.25mm in non-fertile portions, 0.35mm in fertile portions. Autozooids arranged in alternating whorls of four, broadly lozenge-shaped; rounded distally, pointed proximally, borders marked by clear sutures; 0.3-0.35 x 0.2mm. Cryptocyst finely granular, deeply concave between paired, curved, longitudinal ridges which fuse with the terminal wall distal to the opesia; extending proximally almost to the proximal end of the autozoid, but not meeting. Opesia about one-sixth total autozoid length; proximal edge convex, rounded, projecting slightly; distal edge finely denticulate; a thick, rounded denticle present in each proximal corner. Fertile portions of internode swollen, with three whorls of autozooids bearing endotoichal ovicells; aperture of ovicell transversely oval, partially occluded by a rectangular plate. Avicularia sparse, as large as an autozoid; mandible semicircular; rostrum resembling a cowl, projecting from the frontal plane of the internode, proximal edge of opesia straight, with two deep notches.

REMARKS

The characteristic avicularia are well figured by Harmer (1926), who provided a synonymy for *C. punctata* (Busk). Avicularia were present in the Heron Island specimen but unfortunately were not scanned. *C. punctata* was originally described from the Queensland coast; it was reported from throughout the Indo-Malay region by Harmer (1926), whose synonymy extended its range westwards to Sri Lanka and Zanzibar, and northwards to Japan.



Superfamily HIPPOTHOOIDEA Busk, 1859
Family HIPPOTHOIDAE Busk, 1859

Hippothoa flagellum Manzoni, 1870

MATERIAL
Stn. B24.

REMARKS

This inconspicuous, creeping bryozoan favours biogenic carbonates as a substratum. Described originally as a Pliocene fossil from Italy, it seems to be one of the few genuinely cosmopolitan species of Bryozoa, occurring even in Arctic and Antarctic seas. The Heron Island colonies showed no significant difference from European, or indeed Antarctic, specimens.

Trypostega Levinsen, 1909

TYPE SPECIES

Lepralia venusta Norman, 1864.

DIAGNOSIS

Colony encrusting, unilaminar. Autozooids with regularly perforated frontal shield; primary orifice deeply sinuate, with prominent condyles, appearing cleithridiate. Operculate heterozooids (zoeciules) interspersed with autozooids. Ovicell hyperstomial, prominent, regularly perforated, closed by autozoid operculum. Basal pore chambers present.

Trypostega venusta (Norman)
(Fig. 7B,C)

Lepralia venusta Norman, 1864: 84, pl. 10, figs 2,3.
Trypostega venusta (Norman) Harmer, 1957: 953.

MATERIAL
Stn. B23.

REMARKS

Trypostega venusta is widely distributed in warm temperate to tropical seas and has been recorded from all of the oceans. It forms thin, rather inconspicuous sheets on biogenic carbonates.

Superfamily ARACHNOPUSIOIDEA
Jullien, 1888
Family EXECHONELLIDAE Harmer, 1957

Exechonella Duvergier, 1924

TYPE SPECIES

Cyclicopora? grandis Duvergier, 1921.

DIAGNOSIS

Colony encrusting. Autozoid frontal shield formed by the fusion of centripetally developing calcareous processes, with thickly rimmed or tubaeform foramina remaining between. A tall, imperforate peristome develops around the orifice. Avicularia, ovicells and spines absent. Multiporous septula present in vertical walls.

Exechonella ampullacea sp. nov.
(Fig. 7E)

MATERIAL EXAMINED

HOLOTYPE: Stn. B27: QMG304975.
PARATYPE: Stn. B27: QMG304977.

DESCRIPTION

Colony encrusting, unilaminar, developing a small, coherent patch, or dividing into short series of two or three autozoid rows. Autozooids oval, convex, separated by deep grooves, with a tall, cylindrical, terminal peristome imparting overall a bottle shape; 0.7-0.9 x 0.45-0.55mm. Frontal shield with 30-40 round foramina, each with a thick, raised, more or less circular rim; peristome finely nodular, imperforate, cylindrical, with a slightly flared rim, up to 0.3mm long when undamaged. Primary orifice transversely oval, without conspicuous condyles. No avicularia present.

REMARKS

This species differs from other described species of *Exechonella* in the small size of its autozooids and in the proportionately smaller, more densely distributed foramina. It most resembles *E. tuberculata* (MacGillivray) but lacks the spinous frontal processes described in that species by Harmer (1957), and is very much smaller, with smaller frontal foramina, than the specimen illustrated by Gordon (1989a; pl.23, fig.D).

FIG 6. A,B, *Beunia klugei*. A, part of colony, x50. B, distal end of an autozoid, with avicularia, x240. C, *Smittipora cordiformis*, x45. D-F, *Thairopora calcarata*. D, edge of colony, with spines in place, x45. E, cleaned portion of colony, with two avicularia, x55. F, an avicularium in lateral view, x95.

ETYMOLOGY

Latin, *ampullaceus*, flask-like.

Superfamily LEPRALIELLOIDEA

Vigneaux, 1949

REMARKS

Gordon (1993a) published the justification for the unfortunate necessity of using this taxon for the now familiar Umbonuloidea Canu, 1904.

Family EXOCHELLIDAE Bassler, 1935

Escharoides Milne Edwards, 1836

TYPE SPECIES

Cellepora coccinea Abildgaard, 1806.

DIAGNOSIS

Colony encrusting. Autozooids with an umbonuloid frontal shield bordered by large marginal pores. Orifice with a prominent, distal, subapertural plate; bordered proximally by a thickened peristome bearing denticles on its inner face. Oral spines present. Avicularia adventitious, typically lateral to orifice. Ovicell prominent, hyperstomial, imperforate. Basal pore chambers present.

Escharoides longirostris Dumont

(Fig. 8A)

Escharoides longirostris Dumont, 1981: 630, fig. 1A.

Escharoides longirostris, Dumont, Hayward, 1988: 293.

MATERIAL EXAMINED

Stns. 14, 15.

DESCRIPTION

Colony a small, inconspicuous patch. Autozooids broadly hexagonal, convex, separated by deep grooves; 0.45 x 0.40 mm. Frontal calcification smooth, with scattered, round nodules; marginal pores large, round and distinct. Orifice with a low peristome proximally, developed medially as a prominent, rounded mucro bearing on its inner face an angular denticle; paired proximolateral denticles also present on the inner face. Six slender, distal oral spines present, bordering a broad, smooth oral plate. Avicularia single or paired, lateral to orifice, laterally directed; rostrum slender, tapered, 0.2 mm long, hooked distally. Ovicell inconspicuous, recumbent on distally succeeding autozooid and partially im-

mersed; its aperture is marked by an angular lip extending between the bases of the distalmost spine pair.

REMARKS

This species was described from the Sudanese Red Sea coast by Dumont (1981) and subsequently (Hayward, 1988) recorded from Mauritian reefs. Its colonies are always small, rarely exceeding 2-3 mm², and seem restricted to cryptic habitats among coral rubble. This is the first occurrence of the species in Australian waters.

Family LEPRALIELLIDAE Vigneaux, 1949

REMARKS

Gordon (1993a) has demonstrated that *Celleporaria* Lamouroux, 1821 and *Lepraliella* Levinsen, 1917 should be accommodated in the single family Lepraliellidae, which has taxonomic priority over Celleporariidae Harmer, 1957.

Celleporaria columnaris (Busk)

(Fig. 8B-D)

Celleporaria columnaris Busk, 1881: 343, 348, pl. 26, fig. 4; Busk, 1884: 194, pl. 29, fig. 11; pl. 35, fig. 16.

Holoporella intermedia (Busk) Hastings, 1932: 446, text-fig. 20

Celleporaria columnaris (Busk) Harmer, 1957: 677, pl. 42, figs 18-21, 23; Gordon, 1993a: 335, fig. 15-a-d.

MATERIAL EXAMINED

Stns. 16, 25.

DESCRIPTION

Colony a small, multilaminar patch. Autozooids oval, convex, 0.4-0.5 x 0.3-0.35 mm, with finely nodular calcification; frontal marginal pores few in number, widely spaced. Primary orifice wider than long, commonly 0.1 x 0.14 mm; proximal edge almost straight; condyles rounded, conspicuous, no oral spines, no peristome. Suboral avicularium medially situated, perpendicular to orifice plane; rostrum facing laterally, 0.05 mm long, the distal end rounded and coarsely toothed; frequently, the cystid is developed as a stout, spike-like umbo, apparently calcifying in later ontogeny and obliterating the rostrum, which varies little in size. Vicarious avicularia infrequent, smaller than autozooids; rostrum about 0.2 mm long, slender, almost parallel-sided, its distal end deeply cupped, with a coarsely toothed rim.

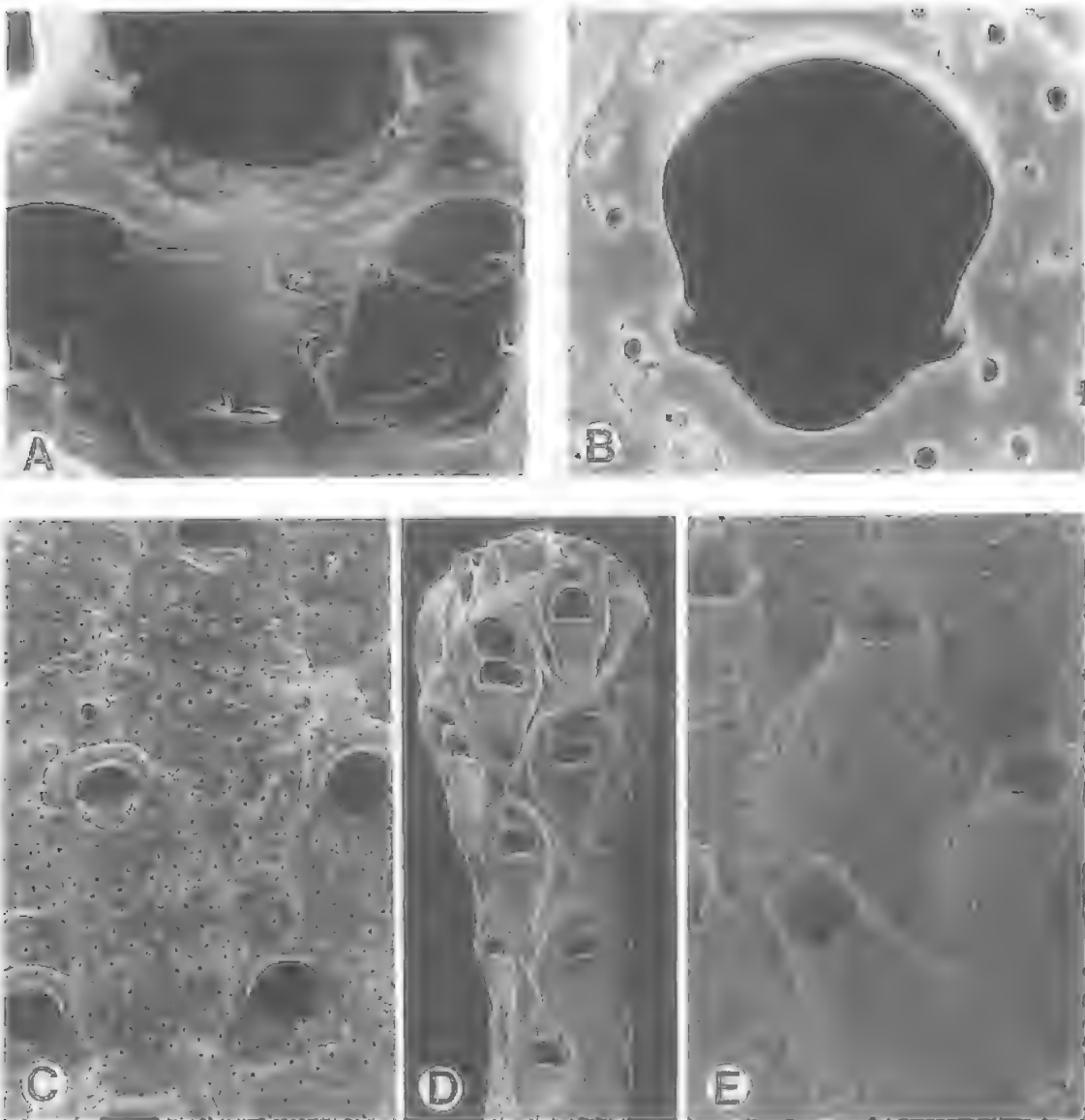


FIG. 7. A, *Thairopora calcarata*, detail to show spicules, x260. B, C, *Trypostega venusta*. B, primary orifice, x450. C, group of autozooids, x90. D, *Cellaria punctata*, x60. E, *Exechonella ampullacea*, x55.

Ovicell slightly wider than long, prominent, with coarsely nodular calcification.

REMARKS

This small species is readily distinguished by its conspicuous condyles and its lack of a peristome. Although the cystid of the suboral avicularium varies in size, often being developed as a prominent columnar umbo, the rostrum is essentially monomorphic and shows little variation in size. *C. columnaris* was originally described from

the Bass Strait (Busk, 1881); Harmer (1957) described material from Indonesia, and his synonymy implied a wide geographical distribution, to Ceylon, the Seychelles and Zanzibar, and northwards to Japan. However, as with all species in this difficult genus, the synonymy of *C. columnaris* needs to be reviewed following re-examination of the specimens on which it is founded. Hasting's (1932) specimens of "*Holoporella intermedia*" from the GBR are referable to *C. columnaris*, and the micrographs of *C. columnaris*

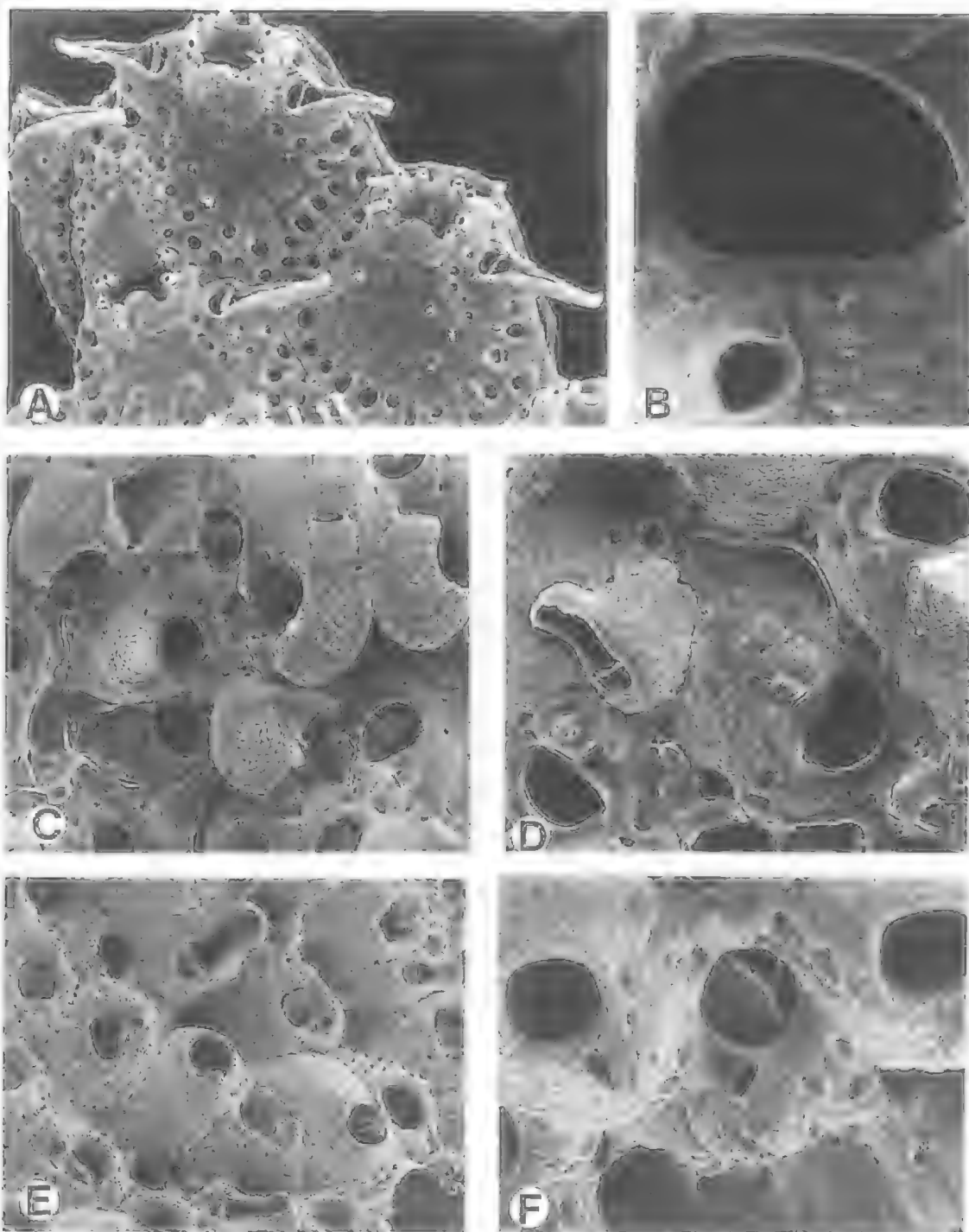


FIG. 8. A, *Escharoides longirostris*, x85. B-D, *Celleporaria columnaris*. B, primary orifice, x340. C, ovicelled autozooids, x60. D, autozooids and an enlarged avicularium, x100. E, F, *Celleporaria granulosa*. E, portion of colony, with enlarged avicularium, x22. F, detail of three autozooids, showing primary orifice, x50.

from New Caledonia published by Gordon (1993b) show the same species as that described and figured here.

***Celleporaria granulosa* (Haswell)
(Fig. 8E,F)**

Cellepora granulosa Haswell, 1881: 40.

Celleporaria granulosa (Haswell) Harmer, 1957: 688,
pl. 43, figs 14-19.

MATERIAL EXAMINED

Stn. B27.

DESCRIPTION

Colony multilaminar, nodular. Autozooids large, convex, with distinct boundaries marked by sharp sutures; 1.0-1.1 x 0.8-0.9 mm. Primary orifice slightly wider than long, 0.25 x 0.3 mm; proximal border shallowly concave, no condyles, no oral spines. Peristomial rim low and thickened. Suboral avicularium medially situated, perpendicular to plane of orifice, facing laterally; rostrum oval, distally rounded, with a smooth rim. Vicarious avicularia as large as autozooids, rostrum 0.8 mm long, broadest across the thickened crossbar, spatulate and deeply cupped distally. Ovicell prominent, spherical. Frontal calcification thick, nodular; with a single series of closely spaced, small, marginal pores, which become increasingly accentuated as calcification thickens.

REMARKS

This distinctive species is recognized by the large size of its autozooids, and the correspondingly large primary orifice, and by its thick, coarsely nodular calcification. The Heron Island specimens have been compared with the paratype specimens described by Harmer (1957) and conserved in the Natural History Museum, London (BMNH reg.nos. 1883.11.29.50, 1910.6.16.6), and there is no question that the two are identical. *C. granulosa* was described from the Queensland coast, and certainly occurs in the Torres Straits. Thornely's specimens of "*Holoporella simplex*" from Cargados Shoal, Indian Ocean, were referred to *C. granulosa* by Harmer, but should now be re-examined before the implied geographical distribution can be accepted.

***Celleporaria hesperopacifica* sp.nov.
(Fig. 9A,B)**

Celleporaria mamillata Gordon, 1993b: 338, fig. 16c.

MATERIAL EXAMINED

HOLOTYPE: QMG304974, on *Sargassum* sp.

PARATYPE: QMG304970, on *Sargassum* sp.

DESCRIPTION

Colony an encrusting, multilaminar sheet; thickening and becoming distinctly mamillate with increasing size. Autozooids tumid, convex, smoothly calcified, with few, indistinct, marginal pores; boundaries distinct at the growing edge, elsewhere only newly budded autozooids clear. Primary orifice orbicular, the proximal border deeply concave between small, rounded condyles. Two long, widely spaced, distal oral spines present in earliest ontogeny only. Peristome well developed, deep and thick, incorporating a vertically-orientated, median suboral avicularium, of widely varying size, the cystid produced apically as a tapered, round-sectioned umbo. Adjacent to the orifice the peristome rim is deeply notched; with ontogenetic thickening the inner edges of this notch close slightly, to define a narrow channel. The avicularium may be very small, <0.05 mm, with a spine-like mucro; or much larger, to about 0.2 mm, with a thick, columnar mucro, with basal diameter about 0.1 mm. In all cases the rostrum is oval, rounded and slightly hooded distally, with fine denticulations on the distal rim. Similar avicularia, equally variable in length, occur on the interstices between autozooids. Ovicell hemispherical, smoothly calcified, except for occasional short spines on the rim above the aperture. In some autozooids a second, slender, spine-like mucro develops on the lateral peristome rim.

REMARKS

This species is most similar to *C. fusca* (Busk) (see Ryland & Hayward, 1992) but differs in its orbicular primary orifice, with deeply concave proximal rim, in its smooth calcification, and in the range of avicularia present. The large vicarious avicularia of *C. hesperopacifica* have a broad, scaphoid, or asymmetrically tapered rostrum, and the crossbar is slender, lacking a columella. Those of *C. fusca* tend to have narrow spatulate rostra and the crossbar bears a stout columella. The suboral avicularia of *C. fusca* show a wider range of size than those of *C. hesperopacifica*, and in the largest the rostral rim is deeply and coarsely corrugate.

ETYMOLOGY

Latin, *hesperus*, west; *pacificus*, referring to the ocean.

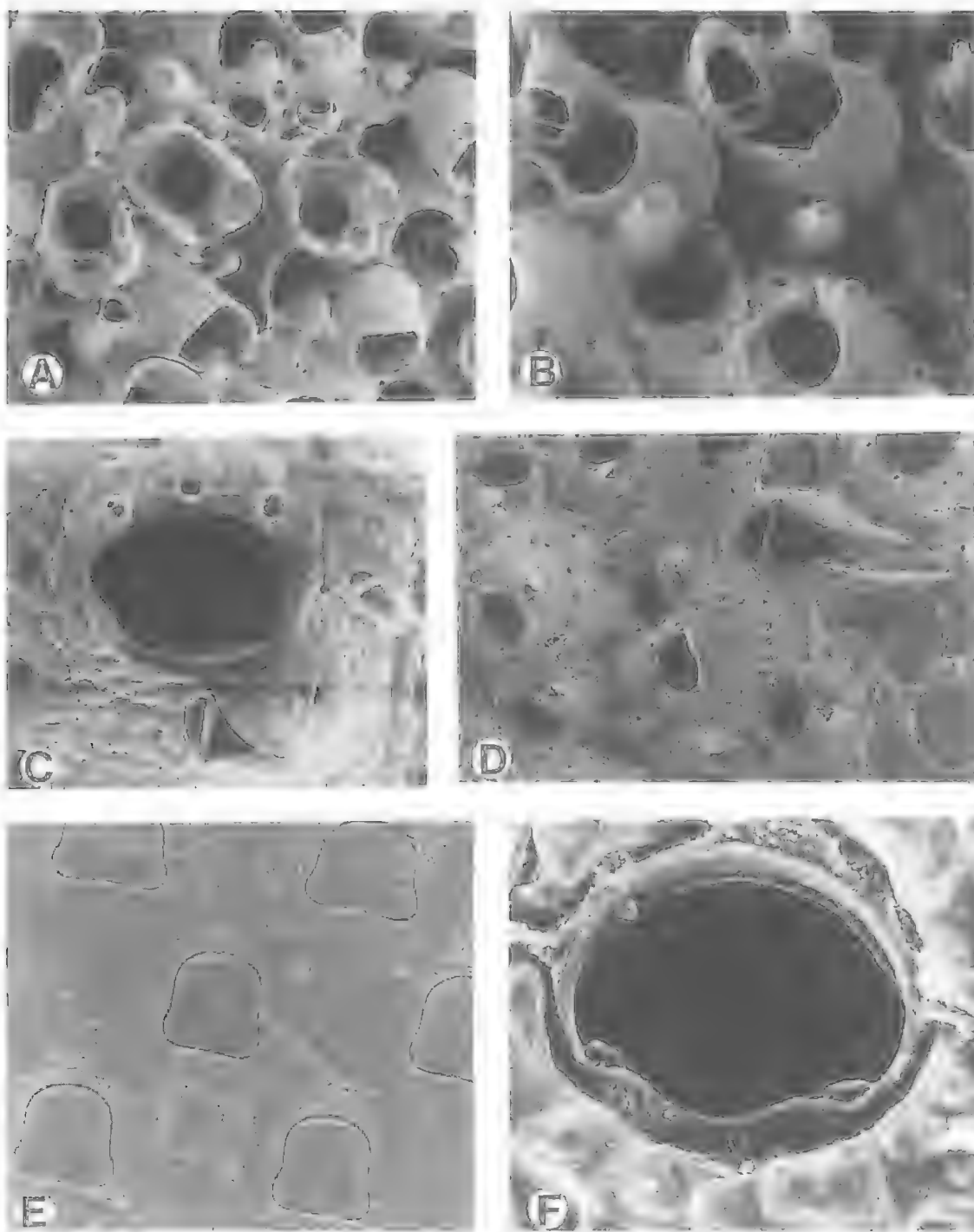


FIG. 9. A,B, *Celleporaria hesperopacifica*. A, group of autozooids and a variety of avicularia, with the broken bases of columnar processes, x130. B, detail showing ovicells, avicularia and columnar processes, x75. C,D, *Celleporaria sicaria*. C, primary orifice, spine bases and characteristic avicularia, x130. D, portion of colony with enlarged avicularium, x40. E, *Pleurotoichus clathratus*, x70. F, *Calypotheca rupicola*, primary orifice, x250.

***Celleporaria sicaria* sp. nov.**
(Fig. 9C,D)

MATERIAL EXAMINED

HOLOTYPE: QMG304965, Stn. 25.

DESCRIPTION

Colony encrusting, multilaminar. Autozooids broadly oval, convex, separated by distinct sutures; 0.6-1.0 x 0.4-0.6mm. Frontal shield calcification finely nodular, with a single series of indistinct marginal pores, and a more conspicuous series of larger pores traversing the shield just proximal to the suboral avicularium. Primary orifice wider than long, 0.12 x 0.22mm, with straight proximal edge; two to four slender, distal oral spines present, peristome developed as a low, projecting lip along proximal edge of orifice. Suboral avicularium medially situated, with substantial cystid; rostrum 0.15-0.2mm, elongate triangular, acute to frontal plane, facing laterally. Vicarious avicularia as large as autozooids, with dagger-like rostrum, 0.5-0.7mm long, pointed distally and with a coarsely toothed rim. Numerous small adventitious avicularia present, developed along one or both of the autozoid frontal pore series; mostly smaller than the suboral avicularium, with elongate oval rostrum. Ovicells not present.

REMARKS

A single colony 1cm² was collected from Stn. 25. The distinctive orifice and suboral avicularium, and striking vicarious avicularium, together distinguish this species from all others presently assigned to *Celleporaria*.

ETYMOLOGY

Latin, *sica*, a dagger.

Superfamily EUTHYRISELLOIDEA

Bassler, 1935

Family EUTHYRISELLIDAE Bassler, 1935

DIAGNOSIS

Colony encrusting; or erect, flexible and rooted. Autozooids with interior cryptocystidean calcification, bounded by an extrazoidial, colony-wide, cuticle, above hypostegal and extrazoidial coelomic space. Avicularia present or absent. Embryos brooded in ovicells or dimorphic female zooids.

***Pleurotoichus* Levinsen, 1909**

TYPE SPECIES

Euthyris clathrata Harmer, 1902.

DIAGNOSIS

Colony erect, flustriform; with broad, branching, unilaminar fronds. Autozooids with cryptocystidean frontal shields consisting of irregular, cuticle-bounded bars of calcite; bounded frontally with exterior cuticular wall, above a hypostegal coelom. Common extrazoidial coelomic space along the margins of the frond, and over the entire basal surface. Multiporous septula present between autozooids. Embryos brooded in dimorphic female zooids with enlarged orifices.

***Pleurotoichus clathratus* (Harmer)**
(Fig. 9E)

Euthyris clathrata Harmer, 1902: 266, pl 16, figs 18-31.

Pleurotoichus clathratus (Harmer) Levinsen, 1909: 270; Cook and Chimonides, 1981: 63, figs 8, 34.

MATERIAL EXAMINED

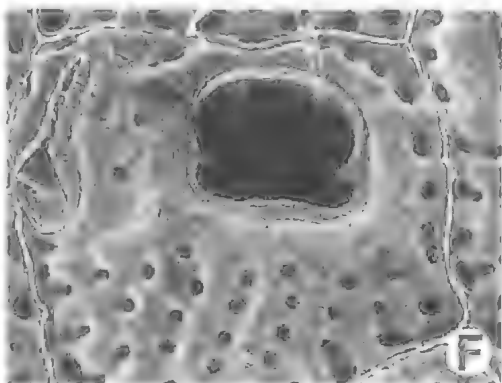
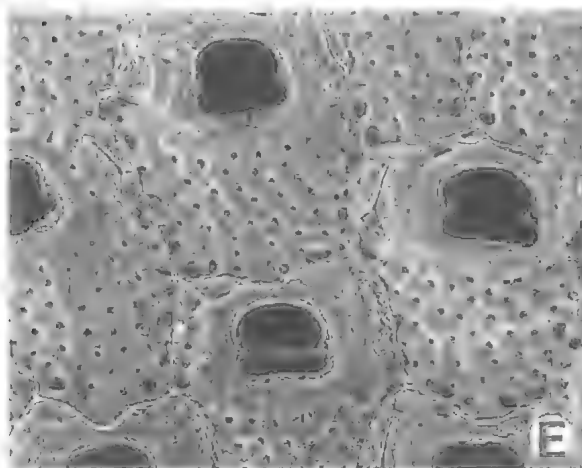
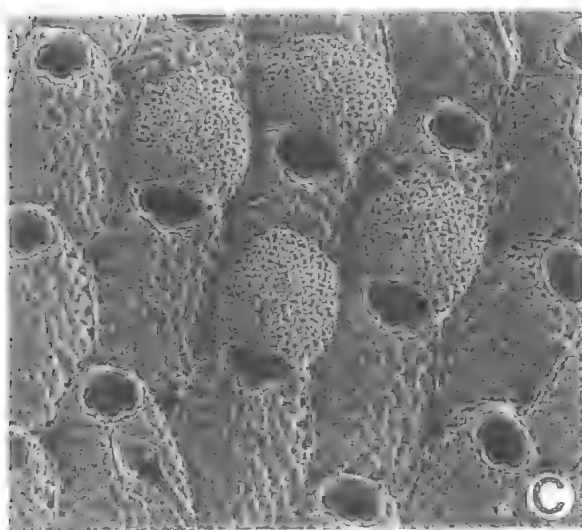
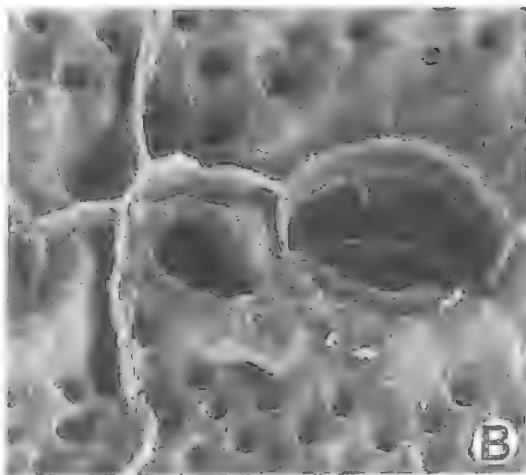
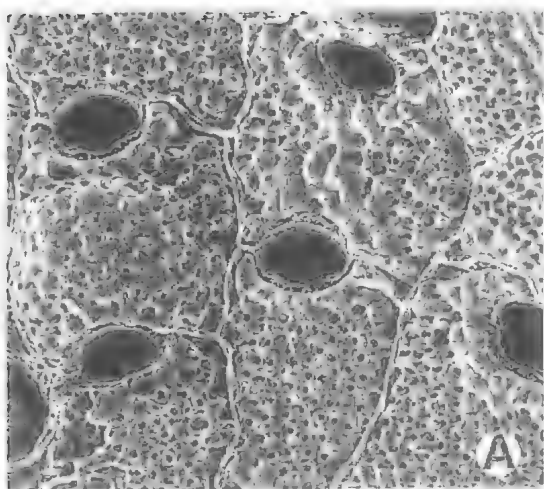
Numerous colonies attached to dead shell and coralline algae, Stn. 28.

DESCRIPTION

Colony erect, flustrine, unilaminar; horny and flexible, present specimens to 110mm high. Branches concavo-convex, almost parallel-sided, but broadening slightly towards distal ends; dividing dichotomously at irregular intervals, but also developing adventitious branches at different levels of the colony; commonly 2-3mm wide in youngest colonies, but up to 8mm in oldest, basal parts of large colonies. Autozooids arranged in regular, alternating longitudinal series, 0.8-0.9 x 0.35mm, with a large, bell-shaped aperture comprising one-third total length. Frontal shield cuticular, underlain by few, irregular calcified skeletal elements, also bounded by thick cuticle. No spines or avicularia; ovicells brooded in dimorphic autozooids.

REMARKS

The colonies are strong and flexible, presumably adapted to withstand considerable water flow and turbulence. They are richly overgrown with epizotes, including numerous hydroids and bryozoans. *Pleurotoichus clathratus* is widely distributed in the Indo-West Pacific region; it has been reported from the coasts of South Australia,



New South Wales and Queensland, and a specimen from Heron Island was described by Cook & Chimonides (1981).

Superfamily SCHIZOPORELOIDEA
Jullien, 1883

Family PARMULARIIDAE Canu & Bassler,
1927

Calypotheca rupicola sp. nov.
(Figs 9F, 10A,B)

TYPE MATERIAL

HOLOTYPE: QMG304959, Stn. 7

PARATYPE: QMG304966, Stn. B21

DESCRIPTION

Colony a spreading, unilaminar sheet. Autozooids rectangular to irregularly polygonal, flat, separated by thick, raised sutures. Primary orifice broader than long; proximal border shallowly concave between short, rounded condyles. Frontal shield densely perforated, the perforations interspaced with smooth, rounded tubercles, which thicken in later ontogeny. A curved band of especially large tubercles extends around the proximal and lateral borders of the orifice, constituting a distinct peristomial rim. Avicularia rather rare; when present, proximo-lateral to orifice, on a slightly inflated cystid; rostrum 0.2 mm long, bluntly triangular, directed medially. Ovicell recumbent on distally succeeding autozooid, not crossed by sutures; slightly broader than long, distinctly flattened; perforation and tuberculation uniform with frontal shield.

Measurements (means and standard deviations of 20 values, mm): autozooid length 0.65 ± 0.06 ; width 0.41 ± 0.06 ; orifice length 0.13 ± 0.007 ; width 0.19 ± 0.007 .

REMARKS

The shape of the primary orifice, and the orientation of the adventitious avicularium in relation to it, together distinguish this species from other described species of *Calypotheca*.

ETYMOLOGY

Latin, *rupes*, rock.

Family CHEILOPORINIDAE Bassler, 1936

Cheiloporina campanula sp. nov.
(Fig. 10E,F)

MATERIAL EXAMINED

HOLOTYPE: QMG304978, Stn. 25.

PARATYPE: QMG304972, Stn. 25.

DESCRIPTION

Colony encrusting, forming a thick, spreading, unilaminar sheet. Autozooids broadly hexagonal, convex, separated by distinct sutures. Frontal shield thick, coarsely nodular, closely and densely perforated by small round pores, the marginal series larger and more irregular than the rest; cuticle clearly visible above the calcified shield, pinkish brown in dried material. Primary orifice distinctly wider than long, proximal margin appearing straight but actually slightly up-curved in the frontal plane; prominent, rounded, downcurved condyles impart a bell-like outline to the orifice. Avicularia lateral to orifice, single or paired, missing in some autozooids; oval proximally, the rostrum abruptly narrowed distal to the crossbar, accommodating a slender, needle-like mandible; size variable, commonly 0.3 mm long, but as small as 0.1 mm, directed distally or medio-distally. Fertile autozooids not observed.

Measurements (means and standard deviations of 20 values, mm): autozooid length 1.02 ± 0.10 ; width 0.70 ± 0.11 ; orifice length 0.24 ± 0.002 ; width 0.30 ± 0.001 ; avicularium length 0.32 ± 0.005 .

REMARKS

In species of *Cheiloporina* the ovicell is reduced and immersed, and brooding autozooids are characterized by dimorphic orifices, which are shorter than those of non-reproductive autozooids and typically trilobed. In *C. campanula* all autozooids have a slightly trilobed orifice with a distinct bell-shaped outline. No dimorphic orifices could be discerned, and the morphology of brooding autozooids remains unknown.

ETYMOLOGY

Latin, *campanula*, a bell.

FIG. 10. A,B, *Calypotheca rupicola*. A, autozooids and an ovicell, x50. B, distal end of an autozooid, with an avicularium, x150. C,D, *Robertsonidra praecipua*. C, portion of colony, with ovicells and avicularia, x40. D, detail of a single autozooid, with avicularium, x150. E,F, *Cheiloporina campanula*. E, group of autozooids, x55. F, detail of a single autozooid, with avicularium, x70.

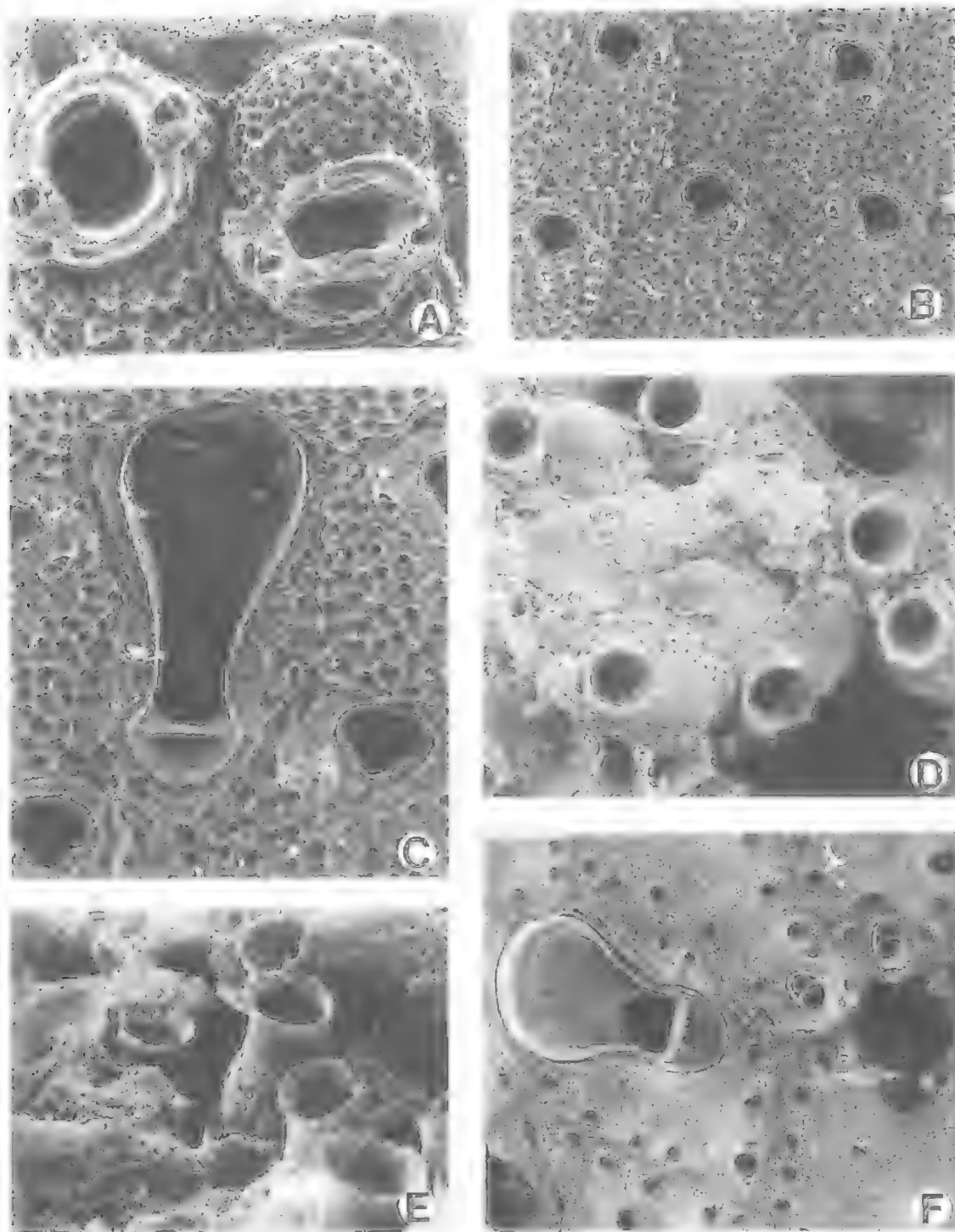


FIG. 11. A, *Gigantopora* pupa, x50. B,C, *Stylopoma herodias*. B, Group of autozooids, x60. C, a vicarious avicularium, x100. D,E, *Nimba saxatilis*. D, group of autozooids, x40. E, autozooids in lateral view, to show peristomes, x45. F, *Cigclisula fruticosa*, x85.

Family GIGANTOPORIDAE Bassler, 1935

Colony encrusting or erect. Autozooids with regularly perforated frontal shield. Primary orifice broadly concave proximally, below prominent lateral condyles. Avicularia adventitious, lateral to orifice, paired; extending medially across the frontal rim of the peristome, above a large, lower foramen. Ovicells hyperstomial or immersed.

Gigantopora Ridley, 1881

TYPE SPECIES

Gigantopora lyncoides Ridley, 1881.

DIAGNOSIS

Colony encrusting; or erect, foliaceous or vinculariiform. Frontal shield nodular, closely perforated. Ovicells hyperstomial, nodular, densely perforated. Uniporous septula present in vertical walls.

Gigantopora pupa (Jullien)
(Fig. 11A)

Galeopsis pupa Jullien, in Jullien and Calvet, 1903: 95, pl. 12, fig. 1.

Gigantopora pupa (Jullien) Harmer, 1957: 880, pl. 60, figs 3,9; Gordon, 1984: 79, pl. 26, fig. F

MATERIAL EXAMINED

Stn 14, a single colony,

REMARKS

This distinctive species was described originally from the Tuamotu Archipelago. It has been recorded since from the Philippine Islands and the Torres Straits (Harmer, 1957) and from the Kermadec Ridge (Gordon, 1984). This is its first occurrence from the GBR.

Family SCHIZOPORELLIDAE Jullien, 1883

Robertsonidra praecipua sp.nov.
(Fig. 10C,D)

TYPE MATERIAL

HOLOTYPE: QMG304955, Stn. 5.

DESCRIPTION

Colony an encrusting, unilaminar sheet. Autozooids oval to hexagonal, convex, separated by distinct sutures. Primary orifice wider than long; with a short, U-shaped sinus occupying about

one-half its proximal width, flanked by short, sharply pointed condyles. Two delicate evanescent spines on distal border, persisting in ovicelled autozooids. Frontal shield with glistening, smoothly nodular calcification typical of the genus, bordered by a single series of large, round, marginal pores. An adventitious avicularium present on a minority (<10%) of autozooids, lateral suboral in position, directed proximo-laterally; opesia triangular, rostrum strongly tapered to a rounded distal tip; crossbar slender, complete. Ovicell recumbent on distally succeeding autozoid, about as wide as long, globular; calcification more finely nodular than that of frontal shield.

Measurements (means and standard deviations of 20 values, mm): autozoid length 0.65 ± 0.05 ; width 0.43 ± 0.04 ; orifice length 0.14 ± 0.006 ; width 0.18 ± 0.009 ; avicularium length 0.37 ± 0.04 .

REMARKS

This species is very similar to *R. novella* Ryland & Hayward 1992, a colony of which was growing adjacent to the unique holotype of *R. praecipua*. Apart from an obvious difference in size, the autozooids also differ in the size and shape of the primary orifice, which in *R. novella* is almost as long as wide (*R. novella*: autozoid length 0.54 ± 0.06 ; width 0.38 ± 0.03 ; orifice length 0.13 ± 0.002 ; width 0.14 ± 0.003 ; avicularium length 0.23 ± 0.04). *R. praecipua* lacks the suboral umbo seen in *R. novella* and also the disto-laterally directed, lateral suboral avicularium characteristic of that species. The enlarged, proximo-laterally directed avicularium which occurs in some autozooids of *R. novella* is very much smaller than that of *R. praecipua*.

ETYMOLOGY

Latin, *praecipuus*, extraordinary.

Stylopoma herodias sp.nov.
(Fig. 11B,C)

MATERIAL EXAMINED

HOLOTYPE: QMG304953, Stn. B24

PARATYPE: QMG304954, Stn. B24.

DESCRIPTION

Colony an extensive, multilaminar, encrusting sheet. Autozooids hexagonal to irregularly polygonal, flat or slightly convex, separated by distinct sutures. Primary orifice wider than long; sinus deep, U-shaped, occupying almost whole of proximal border, and constituting one-third of

total orifice length; condyles small and rounded, inconspicuous. No oral spines; peristome developed as a low ridge of finely granular calcification around distal and lateral borders of orifice. A single, lateral oral, adventitious avicularium present; rostrum bluntly triangular, slightly acute to frontal plane, directed disto-laterally. Frontal shield evenly and densely perforated by large round pores, each surrounded by a rim of thickened calcification. Vicarious avicularia sporadic, larger than autozooids, with gigantic spatulate rostrum; lacking a palate, but with a complete, slender crossbar. Ovicells not observed.

Measurements (means and standard deviations of 20 values, mm): autozoid length 0.57 ± 0.08 ; width 0.34 ± 0.03 ; orifice length 0.10 ± 0.005 ; width 0.12 ± 0.005 .

REMARKS

This species is most similar to *S. thornelyae* Livingstone, but differs in its smaller orifice and proportionately larger, more broadly U-shaped, sinus. In *S. thornelyae* the sinus occupies less than half the total width of the orifice and is flanked by rather prominent knobbed condyles. Enlarged spatulate avicularia occur in *S. thornelyae*, but are adventitious, each developing on the frontal shield of an autozoid.

ETYMOLOGY

Greek, *herodias*, a heron.

Nimba Jullien in Jullien & Calvet, 1903

TYPE SPECIES

Nimba praetexta Jullien in Jullien & Calvet, 1903.

DIAGNOSIS

Colony encrusting, uniserial. Autozoid frontal shield with marginal pores. Orifice sinuate, enclosed by a tall peristome. Adventitious avicularia present, or absent. Ovicell hyperstomial, not closed by autozoid operculum.

Nimba saxatilis sp. nov.
(Fig. 11D,E)

MATERIAL EXAMINED

HOLOTYPE: QMG304951.

DESCRIPTION

Colony encrusting, the autozooids in creeping, uniserial chains, branching at irregular intervals. Autozooids elongate, oval to distinctly club-

shaped, broadest at the distal end. Primary orifice about as wide as long, proximal edge broadly concave, condyles small and knob-like. Peristome well developed, forming an erect tube completely encircling orifice, its rim thin and evenly flared. Frontal shield convex, thick, nodular; bordered by a single or double series of small marginal pores, separated by a well marked groove from the vertical walls. No spines or avicularia. Ovicells not found.

Measurements (means and standard deviations of 20 values, mm): autozoid length 0.63 ± 0.07 ; width 0.37 ± 0.03 ; orifice length 0.13 ± 0.006 ; width 0.14 ± 0.008 .

REMARKS

Despite the moderately large size of its autozooids, colonies of this species were especially inconspicuous among the epifauna of coral rubble; frequently, only the deep, flared peristomes were immediately evident. This feature, and the nodular frontal shield, with marginal pores only, govern the inclusion of this species in *Nimba*. It is distinguished from other members of the genus (Gordon, 1984, 1989a) by its broad sinus and almost tubular peristome.

ETYMOLOGY

Latin, *saxatilis*, found among rocks.

Family STOMACHETOSSELLIDAE Canu and Bassler, 1917

Cigclisula fruticosa sp. nov.
(Figs 11F, 12A,B)

MATERIAL EXAMINED

HOLOTYPE: QMG304950, Stn. 27.

PARATYPE: QMG304979, Stn. 27.

DESCRIPTION

Colony erect, branching, with broad, lobed, regularly dividing branches up to 8mm wide; developing a compact, rigid, three-dimensional structure, 70 x 50mm, 45mm high. Autozooids hexagonal to irregularly polygonal, large, thickly calcified, strongly convex, separated by distinct sutures; 0.7-0.9 x 0.4-0.5mm. Frontal shield finely granular, with large, widely spaced marginal pores, and a few large, irregularly distributed frontal pores; calcification thickens through ontogeny, developing irregular ridges and knobs between the pores. Primary orifice longer than wide, proximal border almost straight, with a short, U-shaped median sinus occupying about

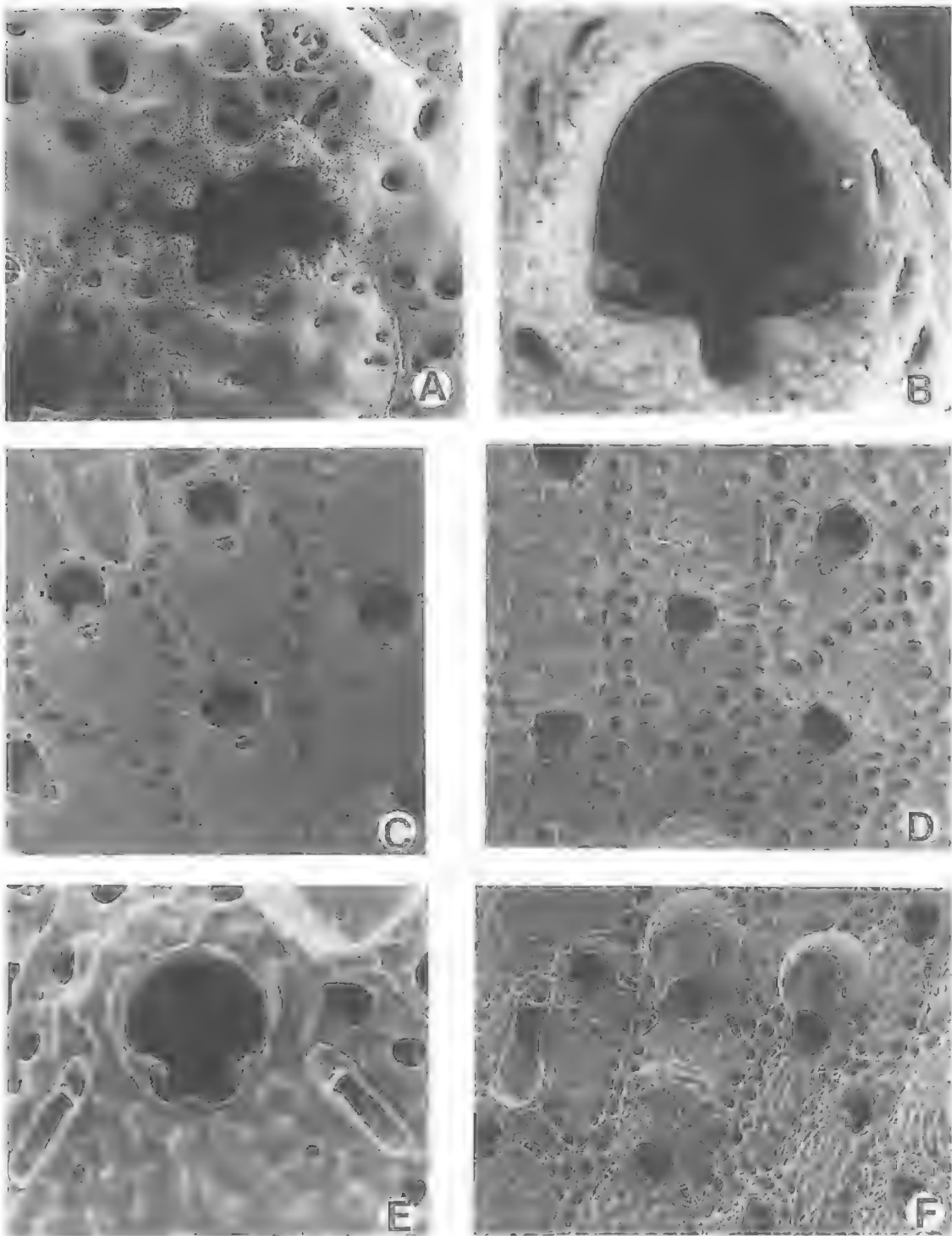


FIG. 12. A,B, *Cigclisula fruticosa*. A, ovicelled autozooid, x90. B, primary orifice, x250. C,D, *Smittoidea incucula*. C, autozooids at the colony edge, x80. D, ovicelled autozooids, x70. E,F, *Pleurocodonellina laciniosa*. E, primary orifice and avicularia, x180. F, ovicelled autozooids and an enlarged avicularium, x55.

one quarter its total width; large, blunt condyles conspicuous in proximo-lateral corners; no oral spines. A low thickened peristome developing in early ontogeny, obscuring but not completely hiding the orifice, its rim variously produced into low, blunt processes. Adventitious avicularia dimorphic: characteristically small, oval, 0.05mm long, with finely toothed rostrum, situated lateral to sinus, acute to frontal plane and laterally directed; rarely larger, 0.2mm long, with elongate oval rostrum. Large vicarious avicularia occur sporadically, the cystid almost as large as an autozooid, bearing a broadly spatulate rostrum, up to 0.4mm long. Additional small adventitious avicularia may be present around the peristomial rim of the autozooid, or elsewhere on the frontal shield. Ovicell longer than wide, convex, conspicuous, bordered by large marginal pores and with a medio-frontal group of about six large, cribrate pores.

Measurements (means and standard deviations of 20 values, mm): autozooid length 0.78 ± 0.06 ; width 0.42 ± 0.04 ; orifice length 0.18 ± 0.006 ; width 0.15 ± 0.005 .

REMARKS

This species is most similar to *C. oclusa* (Busk), which has been accorded a wide, and perhaps spurious, geographical distribution from the Torres Straits to the Philippines, and west to the Red Sea. *C. fruticosa* is distinguished immediately from *C. oclusa* by its elongate, narrowly sinuate orifice, and massive condyles. Ryland and Hayward (1992) recorded *C. areolata* (Kirkpatrick) from Heron Island; both *C. areolata* and *C. cautum* Hastings have been reported previously from the GBR (Hastings, 1932).

ETYMOLOGY

Latin, *fruticosa*, bushy.

Family SMITTINIDAE Levinsen, 1909

Smittoidea incucula sp. nov.
(Fig. 12C,D)

MATERIAL EXAMINED

HOLOTYPE: QMG304952, Stn. 16.

DESCRIPTION

Colony an encrusting, multilaminar sheet. Autozooids polygonal to irregular in outline, convex, separated by thin, raised sutures. Primary orifice slightly wider than long; distal edge with

indistinct denticulation; proximal edge with a conspicuous, thickened lyrula, with convex edge and rounded corners, occupying about half its width; condyles narrow, downcurved, with finely toothed edges. Six distal oral spines present in early ontogeny, obscured by the development of a thin, raised peristome. Frontal shield irregularly nodular, with large, round marginal pores in single or double series. Avicularium almost perpendicular to lyrula, enclosed within peristome; wedge-shaped, broadest across the pivot bar, tapered distally; a thick columella present. Ovicell as broad as long, flattened frontally, with numerous irregularly sized pores; obscured by a sutured oocell cover.

Measurements (means and standard deviations of 10 values, mm): autozooid length 0.52 ± 0.07 ; width 0.33 ± 0.04 ; orifice length 0.12 ± 0.01 ; width 0.12 ± 0.005 .

REMARKS

There are relatively few tropical species of *Smittoidea*, and in reef habitats the genus is usually overshadowed by a diverse fauna of *Parasmitina* species. *Smittoidea incucula* is readily distinguished from other described species by its large, anvil-shaped lyrula and downcurved condyles, and the six distal oral spines. It was not common on the Heron Island reef flat, occurring in just two samples.

ETYMOLOGY

Latin, diminutive of *incus*, an anvil.

Pleurocodonellina laciniosa sp. nov.
(Fig. 12E,F)

TYPE MATERIAL

HOLOTYPE: QMG304956, Stn. B30.

DESCRIPTION

Colony a broad, multilaminar sheet. Autozooids hexagonal to irregularly polygonal, slightly convex, separated by distinct raised sutures. Primary orifice as wide as long, more or less flush with frontal plane of autozooid; proximal edge with a short, rounded-triangular median projection, variably developed; condyles conspicuous, oval, downcurved, with finely serrated edges revealed by SEM. Two very small distal oral spines present in earliest ontogeny, obscured by the development of a low peristomial rim. Frontal shield coarsely nodular, with a single series of large marginal pores. Avicularia lateral suboral, single or paired (or absent), dimorphic;

narrowly elliptical, 0.1 mm long, with a slender crossbar, large palatal foramen and oval opesia, proximo-laterally directed; less frequently, enlarged, to 0.3 mm long, parallel-sided, with cupped, narrowly spatulate distal end and extensive palatal foramen, crossbar thick, opesia oval. Ovicell about as wide as long, flattened frontally, with a ring of large frontal pores; initially smooth, but developing a nodular ooecial cover.

Measurements (means and standard deviations of 20 values, mm): autozooid length 0.55 ± 0.07 ; width 0.37 ± 0.04 ; orifice length 0.12 ± 0.006 ; width 0.12 ± 0.004 .

REMARKS

The open orifice, which is scarcely immersed, and parallel-sided avicularia, with oval proximal opesia seem characteristic of this genus, as do the downcurved condyles. *P. clavacula* Ryland & Hayward (1992) has a very similar ovicell to *P. laciniosa*, but is distinguished by its primary orifice, which is deeply concave proximally, with much narrower condyles.

Family MICROPORELLIDAE Hincks, 1877

Microporella lunifera (Haswell) (Fig. 13A)

Lepralia lunifera Haswell, 1881: 40.

Microporella lunifera (Haswell) Harmer, 1957: 965

MATERIAL EXAMINED

Stn. 25.

DESCRIPTION

Colony an encrusting, unilaminar sheet. Autozooids elongate oval, convex, separated by deep grooves; $0.5\text{--}0.7 \times 0.4\text{--}0.5$ mm. Frontal shield finely nodular, punctured by numerous tiny pseudopores, and with a few slightly larger marginal pores. Primary orifice longer than wide, with seven oral spines; ascopore close to proximal border of orifice, separated from it by a distance equivalent to less than the orifice length; with a thickened, broadly oval rim and a broad, finely toothed, reniform lumen. Avicularia paired, lateral, situated mid-way between ascopore and orifice, directed disto-laterally; the rostrum is short and shovel-shaped, to accommodate a long, setiform mandible. Ovicell recumbent on distally succeeding autozooid; small, spherical, the calcification densely nodular except for a smooth area above the aperture; there is a peripheral ring of large pores.

REMARKS

This species was introduced cursorily, and without illustration, by Haswell (1881) in his account of Queensland Bryozoa. Harmer (1957) described a specimen from Holborn Island, Torres Straits. This record from Heron Island is only the third occurrence of the species; the specimen figured here has been compared with that described by Harmer (1957) and found to match it exactly.

Fenestrulina epiphytica sp. nov. (Fig. 13B,C)

MATERIAL EXAMINED

HOLOTYPE: QMG304960, on *Sargassum* sp.

PARATYPE: QMG304964, on *Sargassum* sp.

DESCRIPTION

Colonies developing small, rounded, unilaminar patches. Autozooids oval, small, separated by distinct grooves; boundaries of incurved vertical walls marked by a low ridge around the frontal shield. Primary orifice wider than long; no distal oral spines. Ascopore situated almost exactly in the middle of the frontal shield, with a thick, transversely oval rim; lumen crescentic, without denticulations. A single series of large, round pores borders the frontal shield, and continues around the distal edge of the orifice; a double series of pores extends between the ascopore and the primary orifice. Ovicell as wide as long, rather flat, smooth-surfaced; ectooecial calcification limited to an indistinct ridge on the frontal shield of the succeeding autozooid, with a series of small, irregular pores between it and the entoecium. The orifice of brooding autozooids is noticeably larger than that of sterile autozooids.

Measurements (means and standard deviations of 20 values, mm): autozooid length 0.41 ± 0.04 ; width 0.30 ± 0.03 ; orifice length 0.09 ± 0.005 ; width 0.12 ± 0.007 .

REMARKS

This small *Fenestrulina* is especially characterised by its incurved gymnocystal, lateral walls, and the distinct rim bordering the frontal shield. The ascopore is also unusually large in relation to the extent of the frontal shield. It was found only on *Sargassum* leaflets.

ETYMOLOGY

Greek, *epi-*, upon, *phyton*, plant.

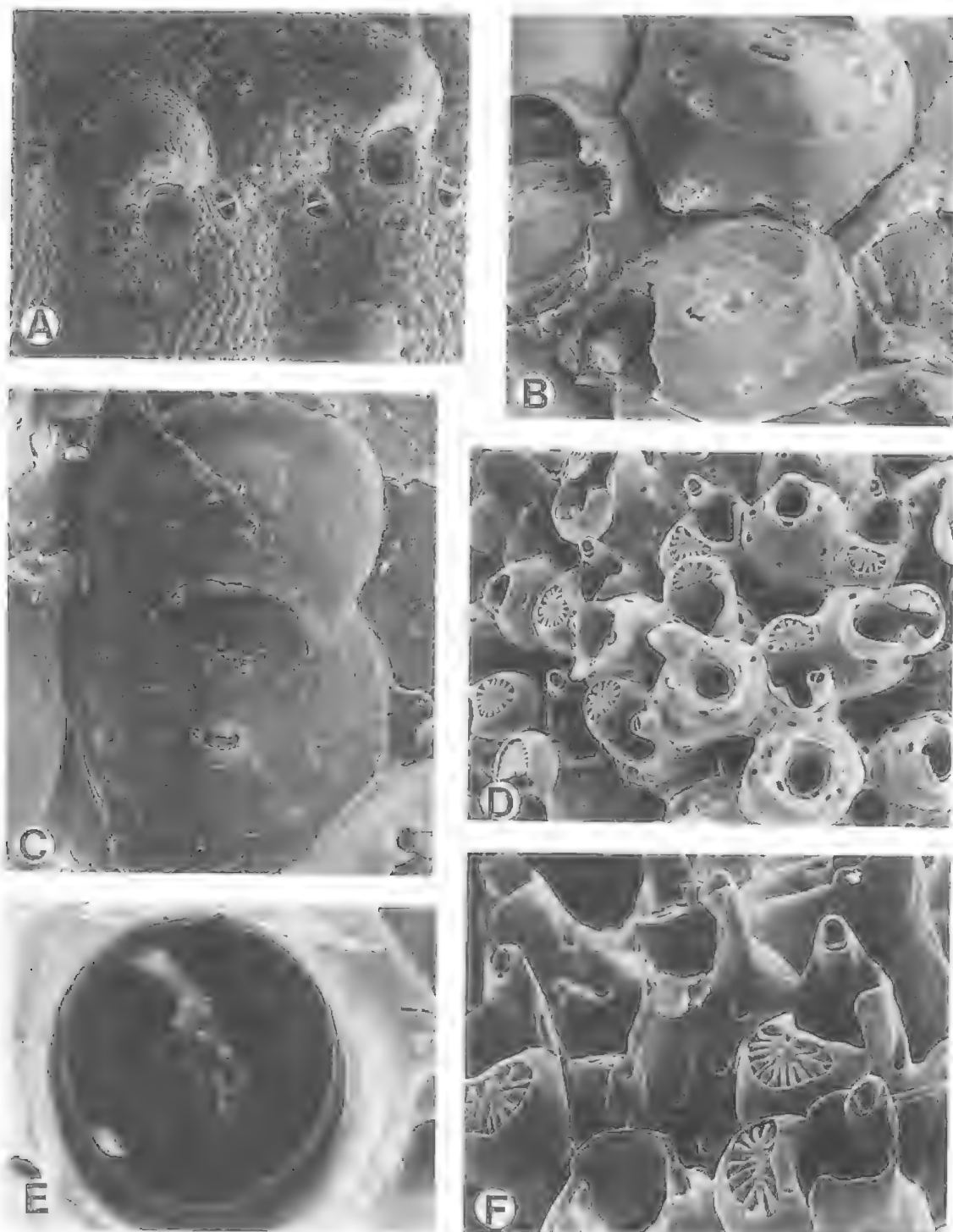


FIG. 13. A, *Microporella lunifera*, x70. B,C, *Fenestrulina epiphytica*. A, portion of a colony, x110. B, detail of an ovicelled autozoid, x140. D-F, *Celleporina bellatula*. D, portion of colony, including ovicelled autozooids, x60. E, primary orifice, x450. F, detail showing peristomes in profile, x110.

Superfamily CELLEPOROIDEA

Johnston, 1838

Family CELLEPORIDAE Johnston, 1838

Celleporina bellatula sp. nov.

(Fig. 13D-F)

MATERIAL EXAMINED

HOLOTYPE: QMG304971, Stn. 28.

PARATYPES: QMG304969, Stn. 28.

DESCRIPTION

Colony pisiform, minute, 1-2mm diameter in the present material. Autozooids small, fusiform, smoothly calcified, closely packed so that the orifice and peristome are terminal in position and little of the frontal shield can be seen in later ontogeny; each has about five small marginal pores. Primary orifice slightly longer than wide, about 0.09×0.085 mm; proximal edge with a short V-shaped sinus occupying about one-third its total width, condyles narrow, indistinct, except for a short peak disto-laterally. Peristome well developed, erect, slightly flared, with an indistinct notch medio-proximally, adjacent to a single columnar avicularian cystid; rostrum 0.05mm long, oval, terminal, acute to plane of orifice and directed obliquely laterally. Large vicarious avicularia were not found. Ovicell slightly wider than long, not encroached upon by the peristome; tabula large, with an almost straight proximal edge; crossed by finely calcified, slender struts of ectooecial calcification, fusing medially with the underlying entoecium.

REMARKS

Numerous colonies of this tiny species were collected from Station 28, encrusting a large tuft of *Nellia simplex*. In its single, laterally directed suboral avicularium it resembles *C. rostellata* Harmer (1957). That species, however, is characterised by a very broad primary orifice, with a wide sinus occupying most of its proximal width, and a proportionately larger avicularium. *C. rostellata* has numerous vicarious avicularia, with a broad, rounded, scaphoid rostrum.

ETYMOLOGY

Latin, *bellatula*, diminutive of *bellus*, beautiful.

Celleporina cochlearia sp. nov.

(Fig. 14A,B)

MATERIAL EXAMINED

HOLOTYPE: QMG304976, Heron Id., on *Sargassum* sp.

DESCRIPTION

Colony a small, domed patch, 2-3mm diameter. Autozooids small, tumid, smoothly calcified, with few, large marginal pores. Primary orifice terminal, 0.10mm long, about as wide as long; rather angular, the proximal edge concave, between indistinct condyles. Peristome developed from a pair of large septula flanking the orifice; short and thick laterally, thickened and umbonate proximally; incorporating a single median suboral avicularium, with short oval rostrum, acute to orifice plane and proximally directed. Ovicell more or less hemispherical; tabula flat and occupying most of frontal surface, with irregular slits around its periphery. Vicarious avicularium distinctive, 0.3mm long, broadest across the slender crossbar; proximal portion more or less semicircular, rostrum long and slender, only half width across condyles, almost parallel-sided with a smoothly rounded tip.

REMARKS

This small *Celleporina* occurred only on *Sargassum*, but was abundant in the samples collected. It is especially characterized by its single, median suboral avicularium, by the broad frontal tabula to the ovicell, and by the long, slender avicularium, which resembles a cook's ladle.

ETYMOLOGY

Latin, *cochlear*, a ladle.

Celleporina fistulata sp. nov.

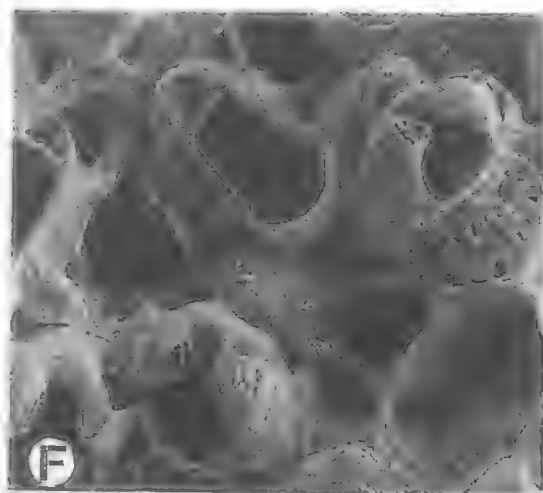
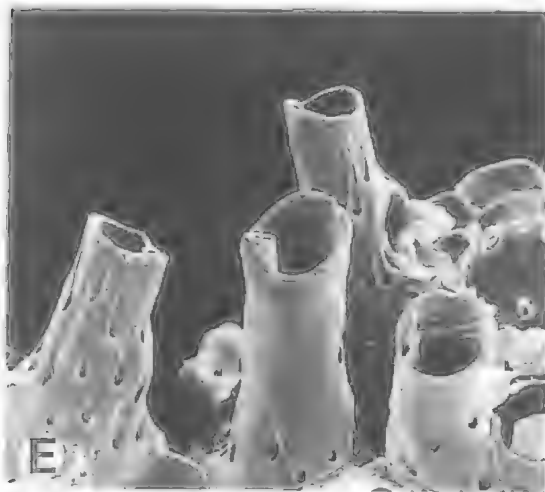
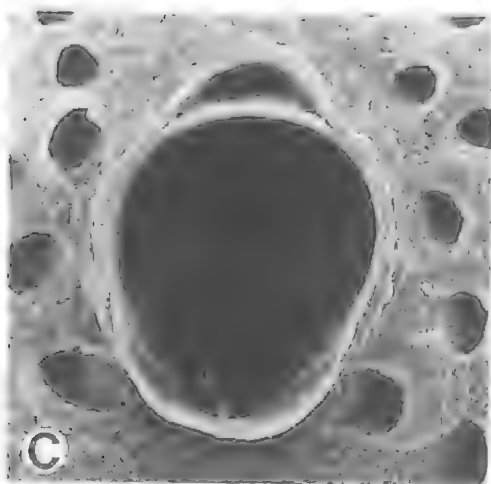
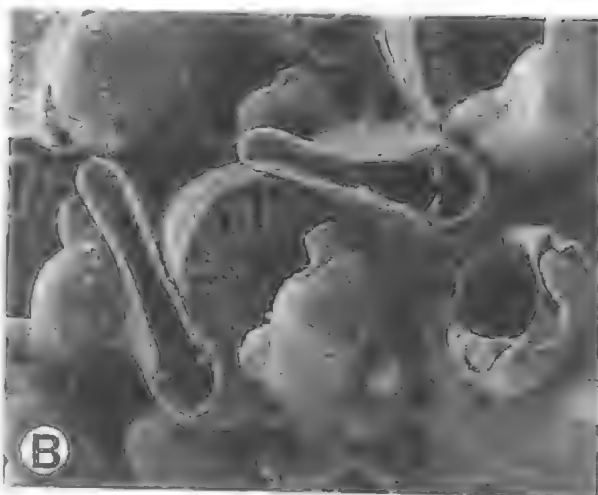
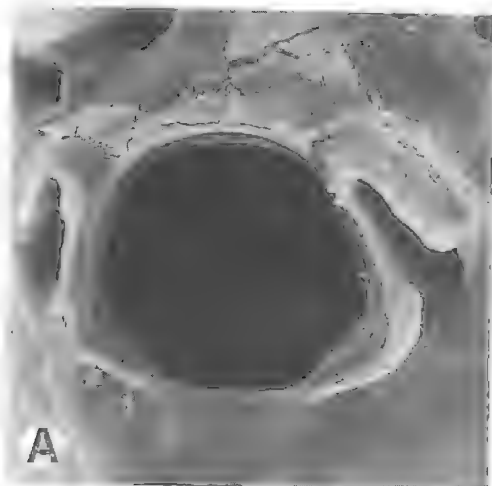
(Fig. 14C-E)

MATERIAL EXAMINED

HOLOTYPE: QMG304973, Stn. 28.

DESCRIPTION

Colony pisiform, or cylindrical. Autozooids oval and convex when newly budded; calcification smooth, with one or two proximal marginal pores, and a triple series of closely spaced pores around the distal half of the autozoid; $0.4-0.45 \times 0.3$ mm. Primary orifice pear-shaped, longer than wide, 0.12×0.08 mm, the proximal edge deeply sinuate between inconspicuous condyles; no oral spines. Peristome developed as an erect tube, 0.4-0.5mm high, completely hiding orifice, smoothly calcified, with tubular extensions of the autozoid pores around its basal half. A single, tubular avicularium incorporated within the peristome, its rostrum triangular, 0.06mm long, situated on the proximo-lateral rim, slightly acute to secondary aperture, directed outwards. Other avi-



cularia not found. Ovicell wider than long, irregularly oval, situated at base of peristome; entoecial tabula occupying most of frontal surface, finely granular, bordered by thickened struts of ectoecium.

REMARKS

This small *Celleporina* is especially characterised by its pear-shaped primary orifice and long, tubular peristome, bearing just a single avicularium on its rim. Colonies were encrusted on *Pleurotoichus clathratus* from Station 28.

ETYMOLOGY

Latin, *fistula*, a pipe.

Celleporina rostellata Harmer (Fig. 14F, 15A,B)

Celleporina rostellata Harmer, 1957: 907, pl. 62, figs 18, 19.

MATERIAL EXAMINED

Numerous colonies on beached *Sargassum* sp.

DESCRIPTION

Colonies developing small patches, nodules or cylinders, 2–3 mm long. Autozooids smoothly calcified, closely packed; frontal shield, visible only in marginal autozooids, with few, relatively large, marginal pores. Primary orifice slightly longer than wide, 0.15 × 0.12 mm; proximal edge with a deep, U-shaped sinus occupying half its total width; condyles low and rounded. Peristome developed in early ontogeny, characteristic: completely surrounding orifice and incorporating a proximo-lateral, suboral avicularium, with oval, vertically orientated rostrum, the distal rim finely denticulate; medio-proximal rim deeply notched, opposite proximo-lateral edge developed as a thickened umbo. The avicularium faces laterally; its proximal edge is produced as a sub-triangular process projecting above the peristomial notch. Ovicell hemispherical with a large frontal tabula, perforated by two rows of irregular pores. Vicarious avicularia frequent, varying in size, up to 0.27 mm long; rostrum slightly broadened distally, and deeply cupped; crossbar complete, with an indistinct median thickening; palate with an extensive foramen.

REMARKS

The specimens described by Harmer (1957), from the Torres Straits (Fig. 15b), had grown as slender cylinders, probably investing hydroid stems. They bear a close resemblance to the Heron Island specimens. This appears to be just the second report of the species, and its first occurrence in the GBR province.

Family PHIDOLOPORIDAE Gabb & Horn 1862

Plesiocleidochasma Soule, Soule & Chaney, 1991

TYPE SPECIES

Lepralia porcellana var. Livingstone, 1926.

DIAGNOSIS

Colony encrusting, unilaminar to multilaminar. Autozooid frontal wall with few marginal perforations; primary orifice orbicular, smooth-rimmed, with sharp, downcurved condyles above a broad, arcuate sinus. Avicularia adventitious, typically latero-proximal to orifice, distally or laterally directed. Ovicell hyperstomial, imperforate, with well-developed labellum, not closed by autozooid orifice.

Plesiocleidochasma normani (Livingstone)

Lepralia porcellana var. *normani* Livingstone, 1926: 92, pl. 8, fig. 1.

Plesiocleidochasma normani (Livingstone) Soule, Soule & Chaney, 1991: 474, pl. 4, fig. 4, pl. 3, fig. 3.

Schedocleidochasma porcellanum (Busk) Ryland & Hayward, 1992: 287, fig. 27c.

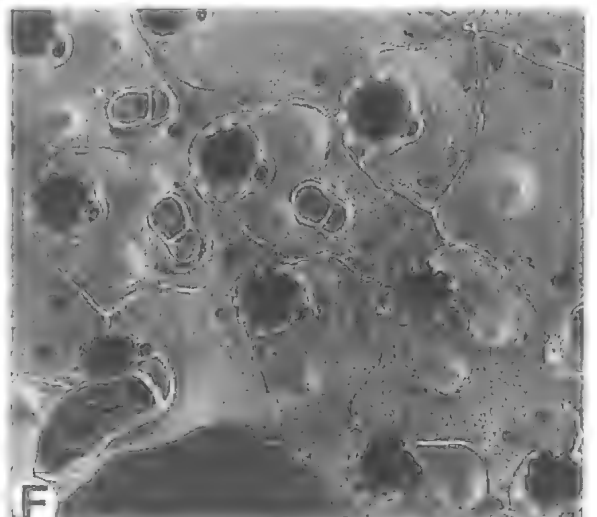
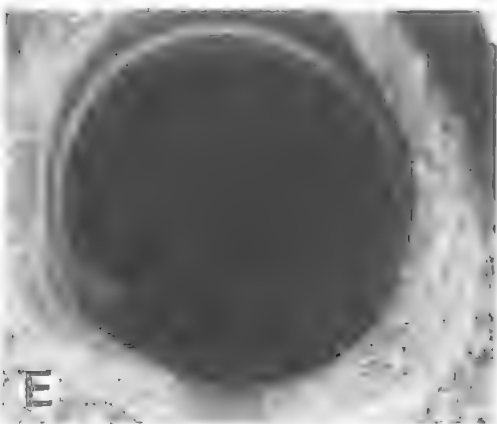
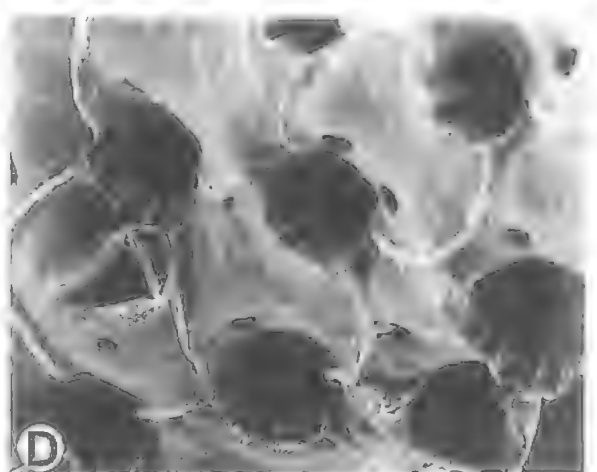
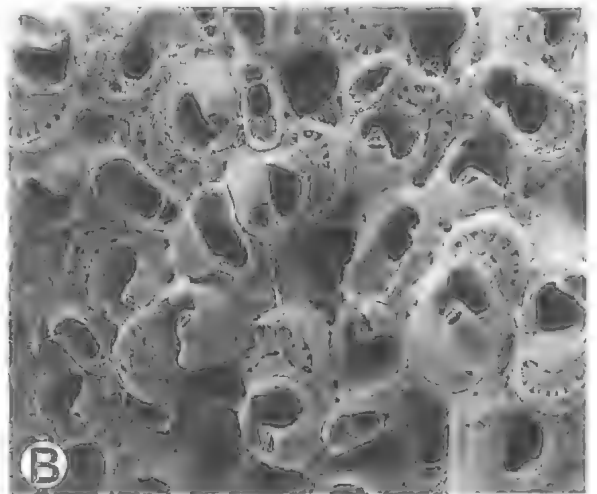
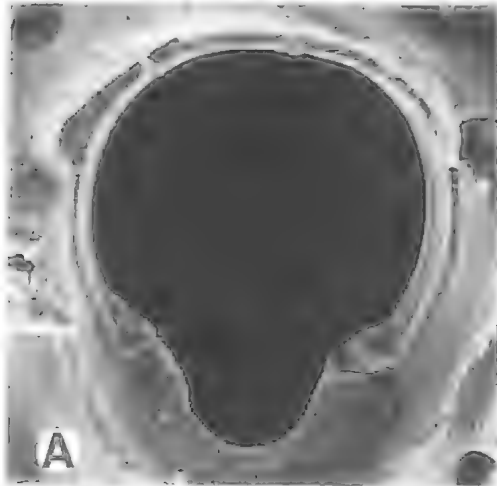
REMARKS

This species was incorrectly attributed to *Schedocleidochasma porcellanum* by Ryland & Hayward (1992). It has proved to be common at Heron Island, occurring at 21 of the sites sampled.

DISTRIBUTION

Plesiocleidochasma normani seems to be widely distributed in the western Pacific. Soule *et al.* (1991) record it from Indonesia, the Solomon

FIG. 14. A,B. *Celleporina cochlearia*. A, primary orifice, x320. B, ovicelled autozooids with characteristic peristome, and vicarious avicularia, x110. C-E, *Celleporina fistulata*. C, primary orifice, x270. D, ovicelled autozooids, x70. E, peristomes in lateral view, x70. F. *Celleporina rostellata*, part of colony, with ovicelled autozooid and vicarious avicularium, x90.



Islands, Fiji and Vanuatu, and eastwards to Tonga, French Polynesia and Hawaii.

***Reteporellina denticulata* (Busk)**
(Fig. 15C,D)

Retepora denticulata Busk, 1884: 109, pl. 26, fig. 1a-d.
Reteporellina denticulata (Busk) Harmer, 1934: 581,
pl. 35, figs 21-23, pl. 38, figs 27-32, text-figs 25D,
33.

DESCRIPTION

Colony architecture indeterminate, generally arising from a narrow basal stalk, developing curved, spreading or twisted lobes of narrow, irregularly dividing branches; fusing irregularly to give an uneven reticulate structure, or partly non-anastomosed; may exceed 40mm height, with equivalent spread. Trabeculae consist of five to nine alternating, longitudinal series of autozooids, each more or less hexagonal, gently convex, separated by distinct raised sutures; commonly 0.5 x 0.3mm. Frontal shield of autozooid smooth, with just two or three large pores marginally, towards its proximal end; thickening steadily through ontogeny, with orifice becoming deeply immersed, sutures more indistinct, but pores remaining visible. Primary orifice wider than long, transversely oval, with small rounded condyles; no oral spines. Peristome with a symmetrical, medio-proximal notch, flanked by prominent, rounded knobs; as this deepens through ontogeny, a deep channel develops on the inner face of the peristome. Avicularia sporadic, suboral, obliquely transversely orientated; the rostrum about 0.2mm long, sharply hooked apically, the tip typically forked. Ovicell pyriform, with a short frontal fissure and a narrow labellum.

DISTRIBUTION

Reteporellina denticulata is widely distributed throughout the tropical Indo-west Pacific region.

***Iodictyum mamillatum* sp. nov.**
(Figs 15E,F, 16A)

MATERIAL EXAMINED

HOLOTYPE: QMG304957, Stn. 27.
PARATYPE: QMG304958, Stn. 27.

DESCRIPTION

Colony an irregular, repent fan shape, supported two or three mm above the substratum by columnar processes developed on its basal surface; area exceeding 20 x 30mm, the edge irregularly folded but not enrolled. Colour dull white. Fenestrulae small, oval, commonly 1.0 x 0.5mm; trabeculae stout, consisting of three or four alternating, longitudinal autozooid series, doubled at points of trabecular fusion. Autozooids hexagonal, becoming irregularly polygonal in later ontogeny, rather flat, separated by distinct raised sutures; 0.3-0.4 x 0.15-0.2mm. Frontal shield finely granular, with two to four, rarely more, large and distinct pores close to its proximal margins; typically, each autozooid bears a pair of prominent, smoothly conical umbones proximolateral to the peristome. Primary orifice orbicular, as wide as long, the proximal border shallowly concave; condyles bluntly rounded, conspicuous; distal rim with relatively large denticulations. No oral spines. A mid-proximal pseudospiramen forms in early ontogeny, developing as a clearly defined tube as the peristome forms; peristome encircling and obscuring primary orifice, with an orbicular secondary aperture, its rim produced into about ten short, blunt, spikes, but without clear internal ridges. Frontal avicularia sporadic, shoe-shaped, normal to frontal plane, with varying orientation; 0.1mm long. Less frequently, slightly larger avicularia occur, 0.1-0.15mm long, with narrow triangular rostrum, acute to frontal plane. Larger avicularia with irregularly spatulate rostrum, 0.2-0.25mm long, occasional, usually borne by autozooids on the margins of the fenestrulae. Ovicells not developed in the present material.

REMARKS

Two colonies only were found. Both had developed as irregular spreading fans with their frontal surfaces more or less parallel to the substratum surface, and attached to it by the thickened base of the colony, and by short, stoutly calcified processes developed from the basal surfaces.

ETYMOLOGY

Latin, *mamillatus*, breast-shaped.

FIG. 15. A,B, *Celleporina rostellata*. A, primary orifice, Heron Island specimen, x330. B, part of the holotype, Torres Straits, x55. C,D, *Reteporellina denticulata*. C, group of autozooids with characteristic avicularia, x120. D, oblique view to show peristomes, x130. E,F, *Iodictyum mamillatum*. E, primary orifice, x550. F, group of autozooids with characteristic umbones and avicularia, x90.

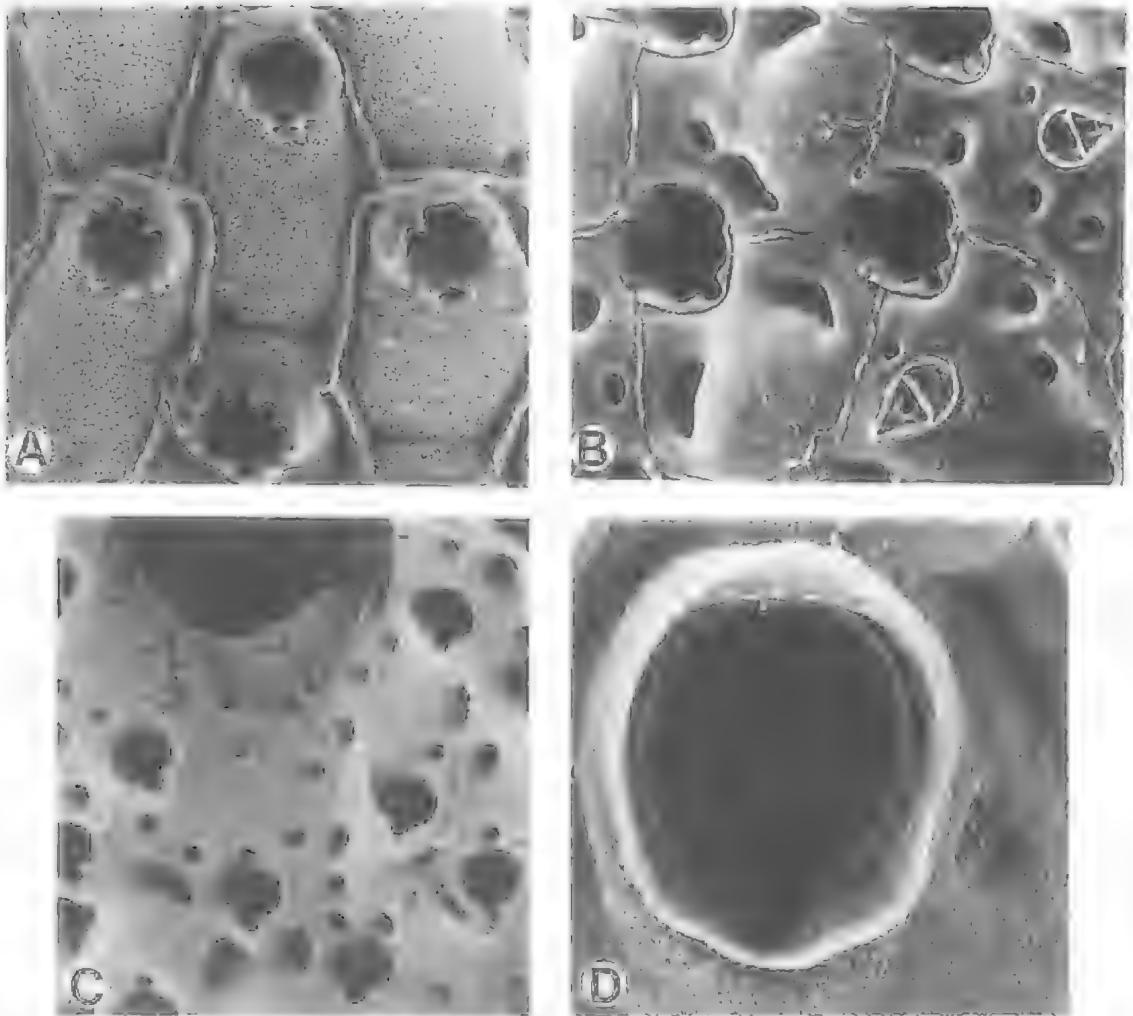


Fig. 16. A, *Iodictyum mamillatum*, autozooids at the growing edge, showing development of peristome, x130. B-D, *Iodictyum receptaculum*. B, ovicelled autozooids, x110. C, autozooids at a fenestrula, with a peristomial avicularium, and a vicarious avicularium, x70. D, primary orifice, x350.

***Iodictyum receptaculum* sp. nov.**
(Fig. 16B-D)

MATERIAL EXAMINED

HOLOTYPE: QMG304949, Stn. 27.

DESCRIPTION

Colony 35mm high, with horizontal spread of 50mm, its basal portion forming a short peduncle, the free edge lobed and folded, the lobes fused at one or two points, resembling a flower basket. Colour deep magenta. Fenestrulae broadly oval, rather small, commonly 1.5 x 1.0mm; trabeculae consisting of four alternating longitudinal series of autozooids, doubled at points of trabecular

fusion. Autozooids hexagonal to polygonal, convex, separated by distinct raised sutures; 0.4-0.45 x 0.2-0.25mm. Frontal wall smooth, with four to six very large marginal pores. Primary orifice pyriform, broadest distally, tapered proximally to a deep U-shaped sinus which occupies whole of proximal edge; condyles small and rounded, distal denticulations comparatively large, distinct. No oral spines. Peristome projecting when newly developed, later submerged by thickening calcification and opening flush with autozooid surface; with a symmetrical, semicircular notch mid-proximally, continued within the peristome as a defined groove; rim produced into four or five indistinct peaks on each side, not markedly

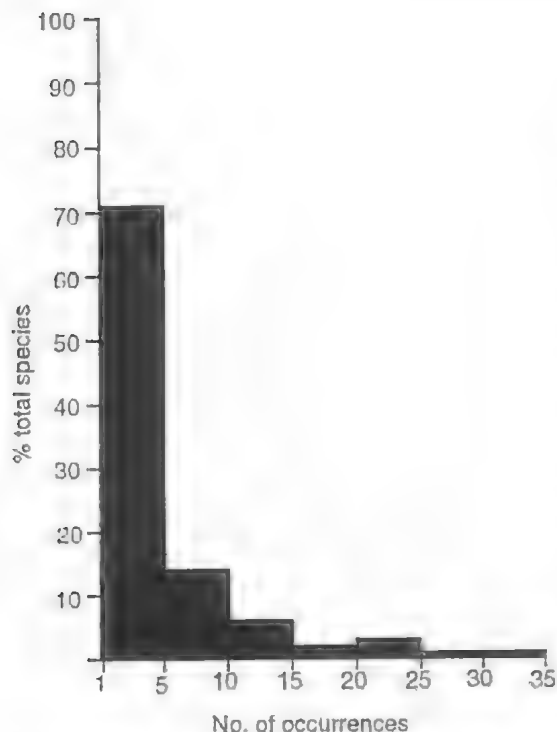


Fig. 17. Species richness at 54 hard-substratum stations.

ribbed on its inner surface. Avicularia sporadic, on frontal shield of autozooids, 0.1–0.15 mm long, rostrum elongate triangular, slightly acute to frontal plane, with variable orientation. Rarely, a suboral avicularium present, with inflated cystid proximo-lateral to peristome and slightly curved, slender rostrum, 0.2 mm long, orientated transversely across proximal edge of peristome. Within the proximal edge of each fenestrula a larger avicularium, with slender, lanceolate rostrum, 0.3 mm long. Ovicell pyriform, with a short median fissure and a very long, narrow labellum.

REMARKS

This species differs from most of the known pigmented species of *Iodictyum* in its smooth peristome. It is most similar to *I. buchneri* Harmer, but is distinguished from that species by its deeper coloration, pyriform primary orifice, and slender infrafenestral avicularium. *Iodictyum buchneri* does not seem to develop the sporadic suboral avicularia seen in *I. receptaculum*.

ETYMOLOGY

Latin, *receptaculum*, a vessel.

CONCLUSION

Bryozoan material reported here and in Ryland & Hayward (1992) was collected at 54 sampling stations on the reef flat at Heron Island. Additionally, three species of *Bugula* were collected at Blue Pools and a sample of *Sargassum*, probably originating from a bed of the seaweed between Heron and Sykes reefs, was collected from the beach of Heron Cay. A total of 124 species has now been described from these collections, of which 34 were new to science and 32 were not previously recorded for Australian seas. It is worth restating that of the remaining 58 species few have been adequately described or illustrated in recent decades, and only a very small number of the species described in previous accounts of the GBR Bryozoa (notably Livingstone, 1927; Hastings, 1932) have been collected again. Taxonomic research on Australian Bryozoa remains slow and difficult. In part this is because the taxonomic diversity of Australian bryozoan faunas has always been underestimated, and any faunistic survey will produce a significant number of undescribed species. However, another major problem is the taxonomic confusion surrounding the identity of many species. The lengthy synonymies, and lists of specimens, assembled by Harmer (1957) cannot be relied upon, and species records by earlier authors, unsupported by descriptions or figures, have to be continually reviewed. In all instances it is almost always necessary to re-examine type and other published materials before specimens may be assigned to little-reported or long-unused taxa. Taxonomic precision is greatly aided by scanning electron microscopy, and taxonomic research on Australian Bryozoa will become progressively easier as the fauna is redescribed, and illustrated with high quality SEM micrographs. Bock's (1982) account of the South Australian fauna and Gordon's (1984, 1986, 1989a) works on the New Zealand Bryozoa are models for this type of study.

Some preliminary ecological conclusions may be drawn from this survey of Heron Island reef flat bryozoans. Most obvious is the difference between the hard substratum fauna and that of the single, and perhaps unrepresentative, sample of *Sargassum*. Fifteen species were found growing on *Sargassum* leaflets, but only two, *Aetea anguina* and *Rhynchozoon tubulosum*, were also recorded on coral rubble. The 13 species found only on *Sargassum* included two known epiphytes, *Membranipora tuberculata* and *Electra*

bellula, but no less than six new species, together with another, *Chaperia* sp., which could not be confidently assigned to any described species. The fifty-four hard substratum samples thus yielded 111 species of Bryozoa; the most diverse sample (Stn.25) contained 41 species, while the mean number of species per station was 10.77. The standard deviation (8.49) is high, most stations yielded just 1-5 species, and a simple plot of the data suggests a non-random distribution (Fig.17). The most abundant species was *Hippopodina feegeensis*, a common reef flat species in the Indo-West Pacific, which was present as broad spreading sheets in 32 of the samples. Seven other species together account for more than half the total species occurrences: *Stylopoma duboisii* (29), *Parasmittina hastingiae* (22), *Pleurocodonellina signata* (20), *Plesioleidochasma normani* (21), *Rhynchozoon compactum* (20), *R. splendens* (22) and *R. tubulosum* (23). The first four were generally present as spreading unilaminar or multilaminar sheets, while the three species of *Rhynchozoon* formed small patches or nodules.

ACKNOWLEDGEMENTS

We are grateful to the Nuffield Foundation for the provision of a Travelling Fellowship to JSR (1971/72), to the Royal Society for a travel grant in 1988, and to the Australian Biological Resources Survey for generous financial support. Thanks are also due to Dr. Ian Lawn, director of the Heron Island Research Station, and to Mary E. Spencer Jones (Natural History Museum, London). Dr. M.R. Fordy (SBS, University of Wales, Swansea) is thanked for the scanning electron micrography.

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APPENDIX

List of additional collecting stations.

1. 9 Apr, 1972. Reef flat, Research Station side. thin, plate-like corals with areas of sand.
 3. 10 Apr, 1972. Reef flat, Wistari Reef side. Collections from tubular *Acropora*, either dead or not in vigorous growth, attached or loose but not obviously thrown up by cyclone 'Emily' (Apr, 1972).
 7. 11 Apr, 1972. Reef flat, western side. Bryozoans from the lower side of an *Acropora*, finger-like rather than tubular.
 9. 11 Apr, 1972. Reef flat, western side. Bryozoans from the underside of a detached tabular *Acropora*, growing around the pedestal together with *Lithothamnion*, a thick red sponge, *Margaretta* and lace-corals.
 10. 11 Apr, 1972. Reef flat, western side. Bryozoans from the underside of an attached, living *Acropora*.
 15. 13 Apr, 1972. Bryozoans on coral rock, from a rapids area flowing through a cleft in the reef edge.
 19. 14 Apr, 1972. Bryozoans from coral boulders on the reef crest.
 27. 21 Apr, 1972. Bryozoans collected at about 20 feet depth along the reef edge.
 28. 22 Apr, 1972. North side of reef, at 20-30 feet depth along the reef edge.
- B1-B30: refer to individual boulders deposited by cyclone 'Emily' (Apr, 1972) between Blue Pool and the Coral Cascades, which were sampled during the period 27 July - 2 August, 1988.

THE HOLOTYPE AND ADDITIONAL RECORDS OF *POGONA HENRYLAWSONI* WELLS & WELLINGTON, 1985. *Memoirs of the Queensland Museum* 38(2):574 1995:—Two names have been proposed for a species of bearded dragon (*Pogona*) from black-soil plains, central and western Queensland. *Pogona henrylawsoni* Wells & Wellington 1985 was described from a single specimen with field sightings and one other specimen (QM1051) also cited. Description of the holotype was based on metric and coloration data, with limited diagnostic comparisons. Witten (1994a) claimed that the holotype could not be found among specimens in the Australian Museum (AM), citing a personal communication by R. Sadlier noting the lost holotype. Witten further claimed that the diagnosis was inadequate to differentiate *P. henrylawsoni* from the sympatric *P. vitticeps* (Ahl, 1926), nominated as neotype for *P. henrylawsoni* a specimen of *P. vitticeps* (AMR143896), and described the "*P. henrylawsoni*" as *Pogona brevis*. The description of *Pogona brevis* was largely of scalation, although metric characters (short tail and limbs) were noted from Witten (1994b).

Witten's actions were invalid for two reasons. Wells & Wellington (1985) compared *P. henrylawsoni* to *P. vitticeps*, although one of the claimed diagnostic characters, smooth ventral scales, was shown to be unreliable (Witten, 1994a). Wells & Wellington also noted the small size, short tail and rounded head of their species. The holotype of *P. henrylawsoni*, an ovigerous female, (SVL 130mm), (Wells & Wellington, 1985) is smaller than the minimum mature size for populations of *P. vitticeps* outside Victoria (Witten & Coventry, 1990). A rounded head and short tail were also reported as diagnostic for *P. brevis* (Witten, 1994a). Secondly, the holotype of *P. henrylawsoni* has been in the Australian Museum collection since 1985. The holotype (AMR116984; AM Field No. 16814) was registered on 6.ix.1985, along with other Wells & Wellington types. Witten misinterpreted a letter from R. Sadlier, which noted two other specimens of *P. henrylawsoni* had not been lodged in the collection, but did not mention the holotype (R. Sadlier, pers. comm.).

The holotype of *P. henrylawsoni* (Fig. 1) matches the description of *P. brevis*. Wells & Wellington (1985) did not report on scalation described by Witten (1994a). The holotype has 14 supralabials, 15 infralabials, 5 prenasals, 5 subnasals, 13 internasals, 17 scales between rostral and parietal, 105 midbody scales, 17L/18R subdigital lamellae and 4L/4R femoral + preanal pores. Witten (1994a) reported that the tail length given by Wells and Wellington (1985) was shorter than in the series he examined. I confirm the short tail of the holotype; I measure SVL=126mm and tail length=116mm.

Under the ICZN, existence of both a neotype and holotype for *P. henrylawsoni* requires formal resolution. Application for a ruling is in preparation (Witten, pers. comm.). *P. henrylawsoni* is in common usage (Greer, 1989; de Vosjoli & Mailloux, 1993). Thus stability is served by suppression of the neotype, and retention of *P. henrylawsoni* in its original application.

Details of distribution and ecology of *P. henrylawsoni* are few. Five additional specimens are reported: AMR143864, 5.8km W Landsborough Hwy on Boulia rd, R. Sadlier & G. Shea 3.iv.1994; R144528, 35km by rd S Winton, W. van Devender 23.i.1994; Northern Territory Museum R11415, 19km W. Winton, P. Horner 19.i.1984; R11416, 25km W. Winton, P. Horner 19.i.1984; QM157178, S. of Beryl Stn, 80km E. Winton, A. Emmott 9.iii.1993. Locality data for QM138760-62 (Witten, 1994a) are incomplete. These records are from 81.8km N Muttaborra on Hughenden rd, 54.2km S Hughenden on Muttaborra rd and 21.4km N Hughenden on Hann Hwy respectively. Distribution of this species thus extends from Gregory Downs to Longreach and Aramac. AMR144528 (SVL=120mm) and QM157178 (SVL=117mm) are ovigerous females with 5 and 9 eggs. Ovigerous females have previously been reported in January (Wells & Wellington, 1985), northern hemisphere captives have oviposited mostly between March and June (de Vosjoli & Mailloux, 1993). AMR143864 regurgitated by the elapid *Pseudechis collemi*; is the first record of predation for the species.

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Glenn M. Shea, Department of Veterinary Anatomy, University of Sydney, NSW 2006.



FIG. 1. Holotype of *Pogona henrylawsoni*.

NEW SPECIES AND A NEW GENUS OF EARTHWORMS IN THE COLLECTIONS OF
THE QUEENSLAND MUSEUM (MEGASCOLECIDAE: OLIGOCHAETA)

B.G.M. JAMIESON

Jamieson, B.G.M. 1995 12 01: New species and a new genus of earthworms in the collections of the Queensland Museum (Megascolecidae: Oligochaeta). *Memoirs of the Queensland Museum* 38(2): 575-596. Brisbane, ISSN 0079-8835.

The present study adds to the endemic earthworm fauna of Australia (Megascolecidae), one species of the subfamily Acanthodrilinae (*Rhododrilus glandifera* sp. nov.) and nine species of the subfamily Megascolecinae, in the tribes Perionychini (*Heteroporodrilus montiserratae*, *Terrisswalkerius windsori*, *Cryptodrilus bunyaensis* spp. nov.); Dichogastrini (*Digaster lingi*, *D. moretonensis* spp. nov.); and Megascolecini (*Oreoscolex retrocystis* sp. nov., *Propheretima eungella* gen. et sp. nov., *Propheretima hugalli* sp. nov., and *Spenceriella conondalei* sp. nov.). *Rhododrilus glandifera* is the second species of this primarily New Zealand genus to be described from Australia (both from Queensland). It is possible that it has acquired the microscolecin arrangement of male pores (prostates one pair discharging with the vasa deferentia in XVII) from a precursor with the acanthodrilin arrangement (prostate pores 2 pairs, in XVII and XIX; male pores in XVIII) independently of the New Zealand species. Type localities of *Heteroporodrilus montiserratae*, *Terrisswalkerius windsori*, *Digaster lingi*, *D. moretonensis*, *Oreoscolex retrocystis* and *Spenceriella conondalei* are well within the ranges of their respective genera. However, the insular locality of *D. moretonensis*, on Moreton Island, is of zoogeographic interest and *Cryptodrilus bunyaensis* represents a northern extension for its genus. The new genus *Propheretima*, has been erected for species which resemble the Oriental and Australo-Papuan *Pheretima* assemblage of genera in having setae between the male pores but which are plesiomorphic in retaining the gizzard in segment V, not in the apomorphic location of VIII seen in all *pheretimas*. It endorses the view that the ancestry of the *Pheretima* assemblage was Australian. □ *Rhododrilus*, *Heteroporodrilus*, *Terrisswalkerius*, *Cryptodrilus*, *Digaster*, *Oreoscolex*, *Propheretima*, *Spenceriella*, *Megascolecidae*.

B.G.M. Jamieson, Zoology Department, University of Queensland, Brisbane, Queensland 4072, Australia; 1 September 1995.

Revisionary work on megascolecoid earthworms of Australia has led to recognition of ten new species in collections newly and formerly lodged in the collections of the Queensland Museum. Three of these species, in the genera *Rhododrilus*, *Terrisswalkerius*, *Digaster* and a new genus of the Megascolecini were fixed and preserved in ethanol by Mr. Keith McDonald, E. Ling and A. Hugall for cladistic studies on mitochondrial DNA which are in progress. A further species assignable to the new genus was collected by Dr. G. Dyne and Mr. A. Postle and an additional species of *Digaster*, and a species of *Spenceriella* and of *Heteroporodrilus* were lodged in the Museum collections by Dr. R. Raven and a museum group. Two species, in the genera *Oreoscolex* and *Cryptodrilus*, come from the author's collection. The type localities for the ten species range from the north of Sydney, New South Wales, to the Palmerston National Park on the Atherton Tableland in north Queensland.

Subfamily ACANTHODRILINAE
***Rhododrilus glandifera* sp. nov.**
(Figs 1; 2A-C; 3A-F)

MATERIAL EXAMINED

HOLOTYPE: QMG211465 (Undissected).
PARATYPE: QMG211478 (P1); QMG211511 (P2; includes slide of anterior end). All specimens from 17°35'S, 145°45'E., altitude 400-440m, Palmerston National Park, along track to Nandrooya Falls, Qld. Collected K. McDonald, J. Ledger, D. Ledger, Sep. 1994.

DESCRIPTION

Length 58mm, width, midclitellum, 3.2mm (Paratype 2). Segments 154 (Holotype, posterior amputee), 195 (P2). Colour pigmentless in ethanol. Prostomium not determinable. First dorsal pore 9/10 (H). Setae lumbricin, closely paired; the pairs widely separated; in XXVIII: $aa:ab:bc:cd:dd = 4.7:1.4:7.1:4.1:7$; or $13.0:2.8:13.3:7.4:7.5\%$. Clitellum in XIII-XVII, strongly tumid, saddle-shaped with ventral margins shortly lateral of *b* lines. A pair of combined

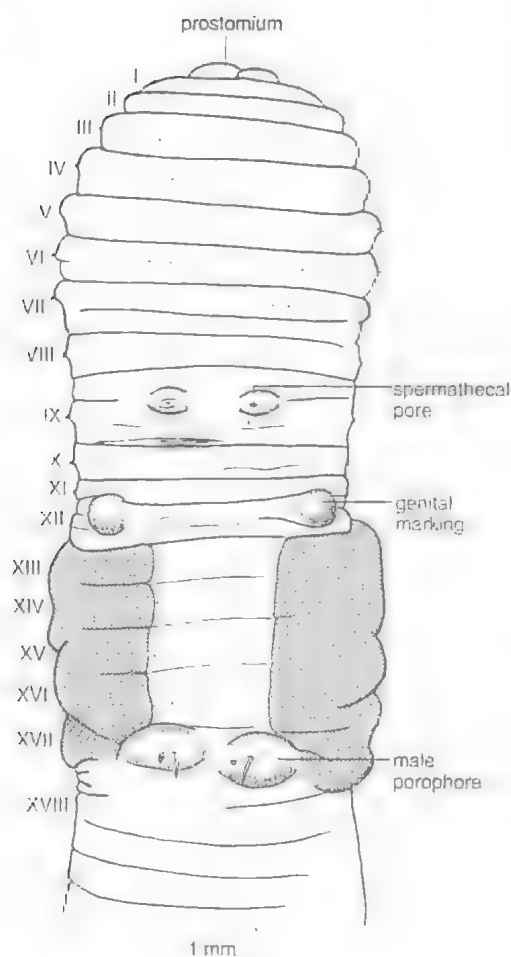


FIG. 1. *Rhododrilus glandifera* sp. nov., Holotype, QMG211465. Forebody and clitellar region.

male and prostatic pores in XVII, on indistinct oval porophores, each pore directly behind two strongly protuberant penial setae; a pair of tubular prostates visible through the body wall, winding from XVII to XXIX. Genital markings: a pair of distinct papillae in intersegmental furrow 11/12, in *bc* (holotype, paratypes acitellate, genital markings undeveloped though penial setae protuberant to exterior). Female pores not recognizable. Spermathecal pores a single pair, in intersegmental furrow 8/9, on conspicuous papillae which extend into VIII and IX (H).

Dorsal blood vessel single, continuous onto the pharynx. Last hearts in XIII. Gizzard large, strongly muscular, in V; preceded by a wide

proventriculus which is not constricted off from it. Calciferous glands: in each of the six segments X-XV there is a conspicuous pair of large, white, nacreous elongate sacs which curve upwards from the ventrolateral aspect of the oesophagus which they invest on each side to its dorsal aspect; in a cleared preparation of the anterior region of paratype 2, each is seen to have longitudinal plications in its proximal half; the glands are not effervescent in acid alcohol. Intestinal origin XVI (P1). Typhlosole not observable. Nephridia avascular holonephridia. Iridescent sperm funnels in X and XI; racemose seminal vesicles in IX and XII. Ovaries, with large oocytes, in XIII. Prostates a single pair, long tortuous and slenderly tubular; each with a slender, poorly demarcated duct. Penial setae present, two (H) to four (P2) projecting at each male porophore; the setae strongly curved, through at least 90°, with a pointed tip; the ectal region of the shaft with numerous palmate ectally directed scales, closely applied to the surface; length of a seta 1.9mm, measured around the curvature, or 1.3mm in a straight line from base to tip (P1). Spermathecae 1 pair, discharging anteriorly in IX; with an ovoid or somewhat clubbed ampulla and a broadly digitiform diverticulum almost as long (left) or about

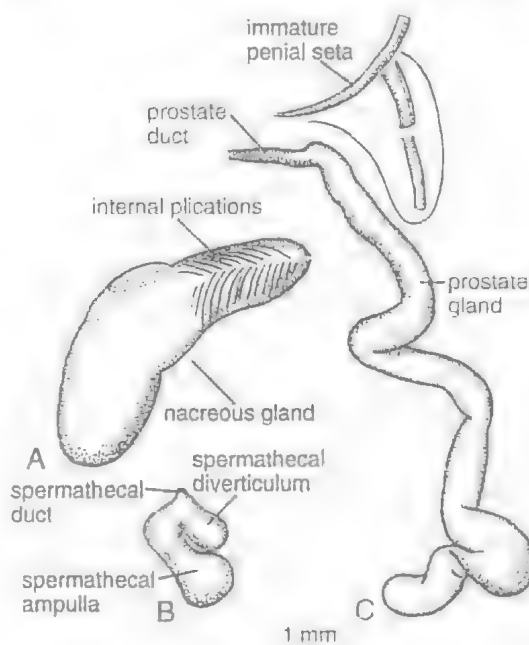


FIG. 2. *Rhododrilus glandifera* sp. nov., Paratype, QMG211478. A, nacreous gland of segment XV. B, right spermatheca; C, right prostate gland.

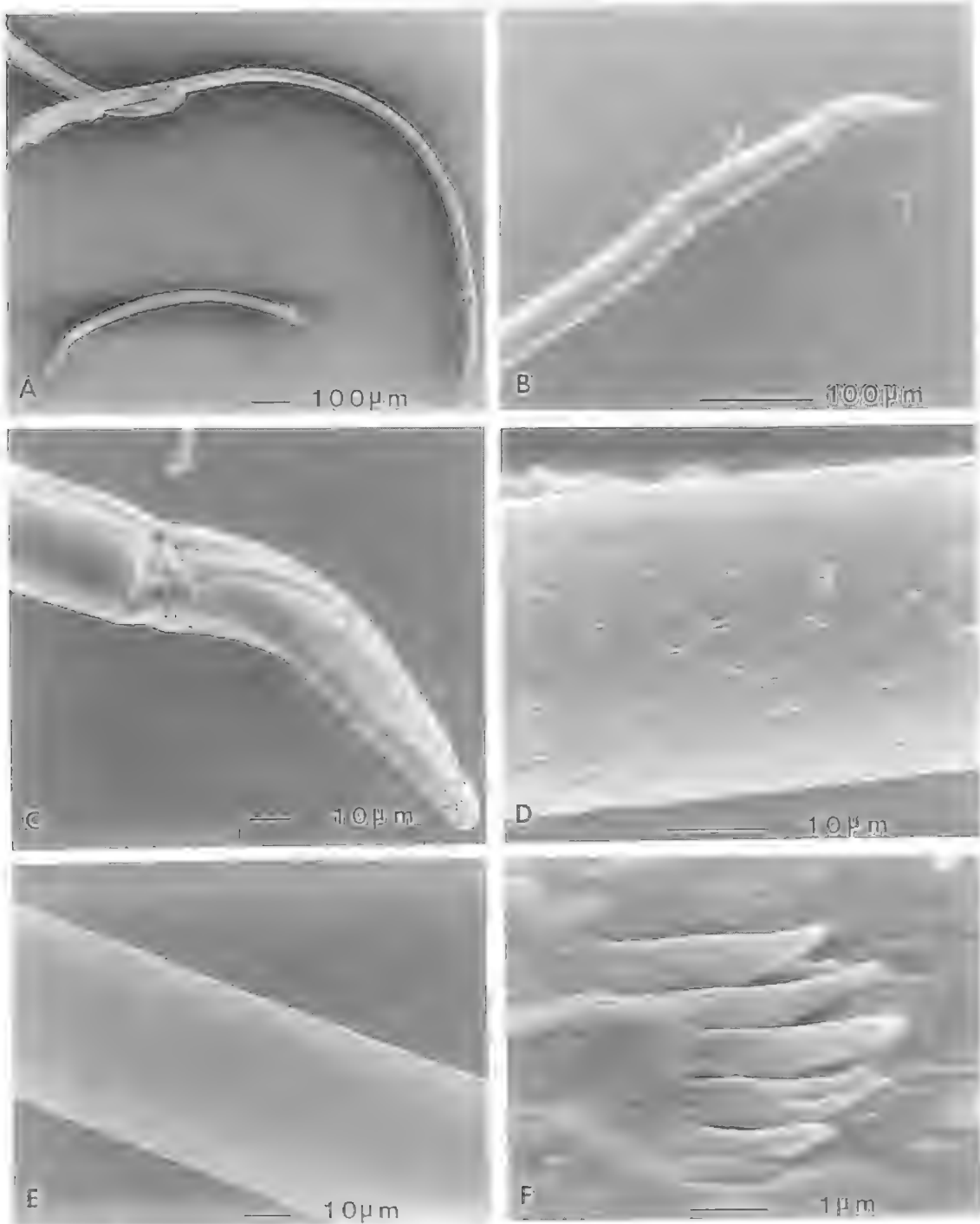


FIG. 3. *Rhododrilus glandifera* sp. nov., Paratype, QMG211478. Scanning electron micrographs of penial setae. A, a whole seta. B, ectal end. C, ectal tip. D, E, scale-like sculpturing of ectal region. F, detail of a scale.

half the length (right), converging at the pore without intervention of an appreciable duct (PI).

ETYMOLOGY

For the highly developed nacreous glands.

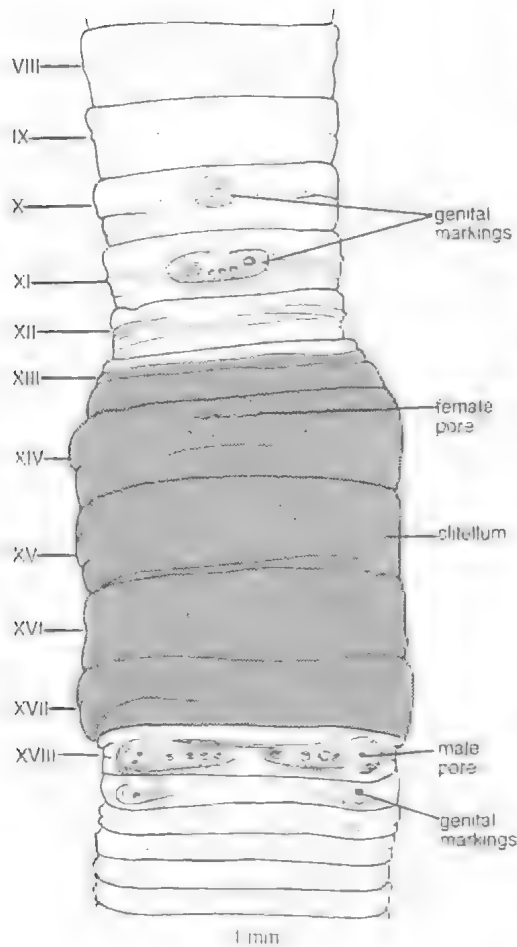


FIG. 4. *Heteroporodrilus montiserratae* sp. nov., Holotype, QMG211443, ventral view of genital field.

REMARKS

Rhododrilus was erected by Beddard (1889) for a New Zealand species, *R. minutus*. The genus was then, as it is now, definable by the combination of the microcolecin arrangement of male pores (a single pair of prostates discharging with the vasa deferentia on segment XVII) with a well developed gizzard. Later workers (Michaelsen, 1916; Lee, 1959; Dyne, 1980) raised the generic total to 31 species, all but one, *R. queenslandicus* Michaelsen, 1916, from New Zealand and neighbouring islands. The new species here described is therefore the second endemic species of *Rhododrilus* to be described from Australia, and from Queensland.

Rhododrilus glandifera differs from *R. queenslandicus* Michaelsen, 1916, in the following respects: the spermathecal pores are in intersegmental furrow 8/9, not in 7/8; and dorsal pores, accessory genital markings and nacreous (calciiferous) glands are present.

Rhododrilus kermadecensis, a euryhaline species described from Tasmania by Jamieson (1974) as *R. littoralis*, differs notably from *R. glandifera* in having 2 pairs of spermathecal pores, in 7/8 and 8/9; in the different distribution of genital markings and in lacking nacreous glands; and is intermediate in the weak development of the dorsal pores.

Subfamily MEGASCOLECINAE

Tribe PERIONYCHINI

Heteroporodrilus montiserratae sp. nov.

(Figs 4, 5, 6)

MATERIAL EXAMINED

HOLOTYPE: QMG211443 (EX G10311).

PARATYPE: QMG211444 (EX G10311). All specimens from 27°57'S, 152°21'E., Mistake Mtns, N. of Cunningham's Gap, Qld., under rocks in complex notophyll vine forest. Collected R. Raven, 6 Oct. 1976.

DESCRIPTION

Length 76mm in the paratype (P); the holotype (H) is a posterior amputee. Width 5.0 (P), 6.4mm (H), segments 217 (P). Pigmentless in ethanol. Prostomium tanylobous, with a transverse furrow at midlength; neither it nor the body canaliculate; peristomium short. First dorsal pore 5/6. Setae

$aa:ab:bc:cd:dd = 2.4:1:2.0:1.7:4.6$; or $14.5:6.1:12:10.6:27.9\%$ (H); in regular longitudinal rows throughout. Nephropores visible as mostly conspicuous dimpling of the intersegments, in the holotype in *d* lines in II-IV; in *c* lines in V and VI, in *c* lines (left) and *d* lines (right) in VII, in VIII-X alternating from *d* to *c* (left) or the reverse (right); in XI and posteriorly, alternation is regular between *d* and *b*, though out of phase on the two sides. Clitellum annular, embracing the posterior 2/3 of XII-XVII, and dorsally the anterior 1/4 of XVIII; strongly tumid in XIV-XVII. Combined male and prostatic pores each a small dark point at the site of the absent setae *b* of XVIII, on indistinct round papillae which fill most of the posterior two thirds of the segment (H); the male field is damaged and not clearly discernible in the paratype. Anterior genital markings in X and XI (H, P); consisting of a low, midventral mostly presetal papilla with pore-like centre in X, and a transverse midventral pad in the setal arc of XI, bearing a pair of pore-like

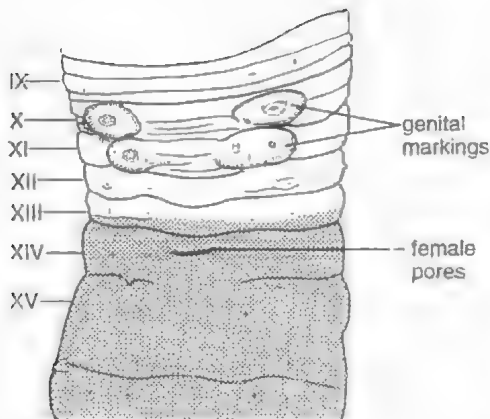


FIG. 5. *Heteropodrilus montiserratae* sp. nov., Paratype 1, QMG211444, showing genital markings differing from those of the holotype though in the same segmental location. Scale as Fig. 4.

markings near its lateral borders and three minute indistinct 'pores' near its posterior border (H); or (P) a pair of transversely elliptical papillae in *ab* of X and XI but less far apart in XI, each pair almost filling its segment longitudinally and with a pore-like centre or (left posterior papilla) with two smaller pore-like markings. Posterior genital markings (H) a narrow, slightly tumid transverse band in the setal arc median to each male papillae, each band with a row of four elliptical pore-like markings, in XVIII; in XIX a tumid area on each side which includes the seta *b* of its side but does not reach the anterior and posterior borders of the segment (H). Female pores a pair of minute apertures in a transverse furrow midway between the setal arc and the anterior border of XIV, almost $1/2aa$, 1.0mm, apart. Spermathecal pores 3 pairs, not externally visible. from internal examination in 6/7, 7/8 and 8/9, the last pair in *ab*.

Septa 8/9-10/11 the strongest, greatly thickened. Dorsal blood vessel single, continuous onto the pharynx. Last hearts in XIII, those in X-XIII latero-oesophageal. Gizzard very large, in V, ensheathed by the very thin septum 5/6 and deflecting several septa posteriorly. Calciferous glands 4 pairs, in X-XIII, sessile ventrolaterally on the oesophagus and almost meeting midventrally. Intestine commencing with abrupt expansion in XV; with no appreciable typhlosole (H, P). Nephridia stomate vesiculate holonephridia; pre-testicular nephridia have wide convoluted ducts each with a terminal swelling constituting a small but definite bladder, by XII the bladder, laterally

situated, is very large and depressed subspheroidal; in the anterior intestinal region, e.g. XVII, the bladder is slightly smaller and is transversely elliptical; further posteriorly (XXXV) the bladder is drawn out medianly in the direction of its supplying duct and projects laterally beyond its excretory pore so that a short broad diverticulum may be considered to exist. Holandric; convoluted sperm funnels, lacking spermatozoal iridescence, in X and XI. Seminal vesicles in IX and XII; those in XII more strongly multiloculate, including a greater development of minute bead-like loculi than those in IX. Ovaries a few short egg strings, in XIII. Prostates racemose and deeply incised; in the holotype with some appearance of a compressed S-shape; limited to XVIII; duct long and muscular, although only a small fraction of the length of the gland; twisted in a loop; entering the body wall in *ab* but nearer *b* (H, P). Spermathecae 3 pairs, in VII, VIII and IX; each with a large thin walled arnpulla, which is widest distal to its equator and is circumferentially pleated, and a very small, narrow muscular duct which is joined at its junction with the am-

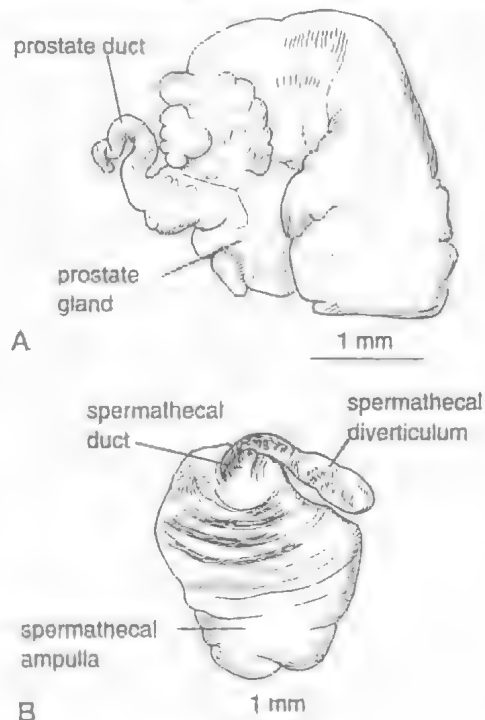


FIG. 6. *Heteropodrilus montiserratae* sp. nov., Holotype, QMG211443. A, right prostate gland. B, right spermatheca of segment IX.

pulla by a digitiform uniloculate diverticulum containing many iridescent sperm masses (H, P).

ETYMOLOGY

Refers to the type locality Mistake Mountains.

REMARKS

Heteroporodrilus montiserratae is distinguished from other species of the genus in possessing four pairs of calciferous glands and three pairs of spermathecae.

Terrisswalkerius Jamieson, 1994

The key to species given by Jamieson (1994) is emended below to accommodate the new species, *T. windsori*, and to acknowledge the presence of five pairs of spermathecae and their pores in *T. millaamillaa* which has been established in the present study in a re-examination of the holotype.

KEY TO THE SPECIES OF TERRISSWALKERIUS

1. Spermathecal pores 5 pairs, in or shortly behind intersegmental furrows 4/5-8/9 2
- Spermathecal pores 1 to 4 pairs (rarely unpaired, midventral), in or shortly behind some or all of intersegmental furrows 4/5-8/9 5

Spermathecal pores 5 pairs

2. Spermathecal pores in *a* lines. Last hearts in XIII. (Spermathecal duct very short.) *T. grandis*
Spermathecal pores median to *a* lines. Last hearts in XII. (Spermathecal duct at least one fourth the length of the ampulla) 3
3. Nephridial bladders absent 4
Nephridial bladders present *T. atavus*
4. Male pores well median of *a* lines. Moderately small worms <3mm wide *T. millaamillaa*
Male pores in setal lines *a* or *ab*. Fairly large worms >6mm wide *T. phalacrus*
5. Spermathecal pores in 4 intersegments, 5/6-8/9 or 4/5-7/8, paired or single 6
Spermathecal pores 3 pairs or fewer 9

Spermathecal pores in 4 intersegments

6. Spermathecal pores in 5/6-8/9, unpaired, midventral *T. macdonaldi*
Spermathecal pores 4 pairs, in 4/5-7/8 or 5/6-8/9 7
7. Spermathecal pores 4 pairs, in 4/5-7/8
Spermathecal pores 4 pairs, in 5/6-8/9 *T. terrareginae* 8

8. Prostomium tanylobous, with wide dorsal tongue. (Peristomium short). Nephropores in a straight series on each side *T. erici*
Prostomium epilobous or proepilobous; with longitudinal grooves which continue to the hind margin of the peristomium. Nephropores in an irregularly sinuous series, varying from far dorsally to far ventrally, on each side *T. kuranda*
9. Spermathecal pores 3 pairs, in or in or shortly behind 4/5-6/7, 5/6-7/8, or 6/7-8/9 10
Spermathecal pores 1 or 2 pairs, in some of 4/5-8/9 16

Spermathecal pores 3 pairs

10. Spermathecal pores 3 pairs, in 4/5-6/7 11
Spermathecal pores 3 pairs, in or shortly behind 5/6-7/8 or 6/7-8/9 13
11. Spermathecal diverticulum long and tortuous. Spermathecal pores in the vicinity of *d* to *e* lines 12
Spermathecal diverticulum short and clavate. Spermathecal pores in or between *a* and *b* lines *T. montislewisi* (part)
12. Spermathecal diverticulum longer than ampulla plus duct. (Spermathecal pores in *d* lines) *T. barronensis*
Spermathecal diverticulum shorter than ampulla plus duct. (Spermathecal pores in *d-e* lines) *T. raveni*
13. Spermathecal pores immediately behind 5/6-7/8 *T. covacevichae*
Spermathecal pores in 6/7-8/9 14
14. Male pores very close together, almost contiguous midventrally, on a common field or papilla *T. athertonensis*
Male pores well separated, between setal lines *b* and *f*, on a pair of papillae 15
15. Spermathecal diverticulum simple, shortly clavate *T. canaliculatus*
Spermathecal diverticulum composite, consisting of as many as 4 parallel conjoined tubes with terminal, knoblike seminal chambers; approximately as long as the spermatheca *T. oculatus*
16. Spermathecal pores 2 pairs, in 4/5 and 5/6 or 5/6 and 6/7 17
Spermathecal pores 1 pair, in 6/7 or 7/8 or 8/9 18

Spermathecal pores 2 pairs

17. Spermathecal pores 2 pairs, in 5/6 and 6/7 *T. montislewisi* (part)
Spermathecal pores 2 pairs, in 4/5 and 5/6 *T. windsori*

Spermathecal pores 1 pair

18. Spermathecal pores 1 pair, in or shortly posterior to 8/9. Spermathecal diverticulum long and tortuous 19
 Spermathecal pores 1 pair, in 6/7 or 7/8 20
 19. Spermathecal pores in setal lines c to d
 *T. nashi*
 Spermathecal pores well median of setal lines a
 *T. liber*
 20. Spermathecal pores 1 pair in 6/7 *T. crateris*
 Spermathecal pores in 7/8 *T. blounti*

Terrisswalkerius windsori sp. nov. (Figs 7, 8)

MATERIAL EXAMINED

HOLOTYPE: QMG211466 (Clitellate, posterior amputee).

PARATYPES: QMG211457 (P1, ac clitellate, intact; P2-4, clitellate posterior amputees). All specimens from 16°15'S, 145°02'E, Windsor Tableland, hut site altitude 1060-1080m, Qld. Collected K. McDonald, 27 Mar 1993.

DESCRIPTION

Length 155mm. Width (midclitellar) 7mm. Segments 266 (P1). Pigmentless in alcohol. Prostomium pro-epilobous, strongly canaliculate. Peristomium very short, bisected dorsally and ventrally. Body weakly canaliculate dorsally. First dorsal pore 5/6 (H, P1). Setae minute and difficult to discern; dorsal interval (zz) narrow and similar to adjacent intervals; ventral interval (aa) about 3-4 ab, throughout; approximately 36 or 48 setae in XII (H, P1). Nephropores in a straight series on each side, slightly lateral of middorsum in the forebody, though near mid-ventral in segment II; dorsolateral in the hind body. Clitellum annular, XIV-1/2XVIII but extending to 18/19 immediately lateral of the male porophores. Male pores (H, P2-4) minute orifices on small elliptical porophores in the setal arc of XVIII in setal lines d-e, each preceded and succeeded by a large crescentic swelling which constitute a larger porophore which protrudes slightly into the adjacent segments, XVII and XIX. Genital markings absent. Female pores not visible but presumably paired in the transverse furrow situated anteriorly in XIV. Spermathecal pores 2 pairs, in 4/5 and 5/6, dorsolateral, in setal lines 11-12 (H).

Septa 7/8 - 10/11 greatly thickened and funnel-shaped. Dorsal blood vessel single, continuous onto the pharynx. Last hearts in XIII, latero-oesophageal, like the preceding hearts, slender. Gizzard in VI, large, strongly muscular, almost

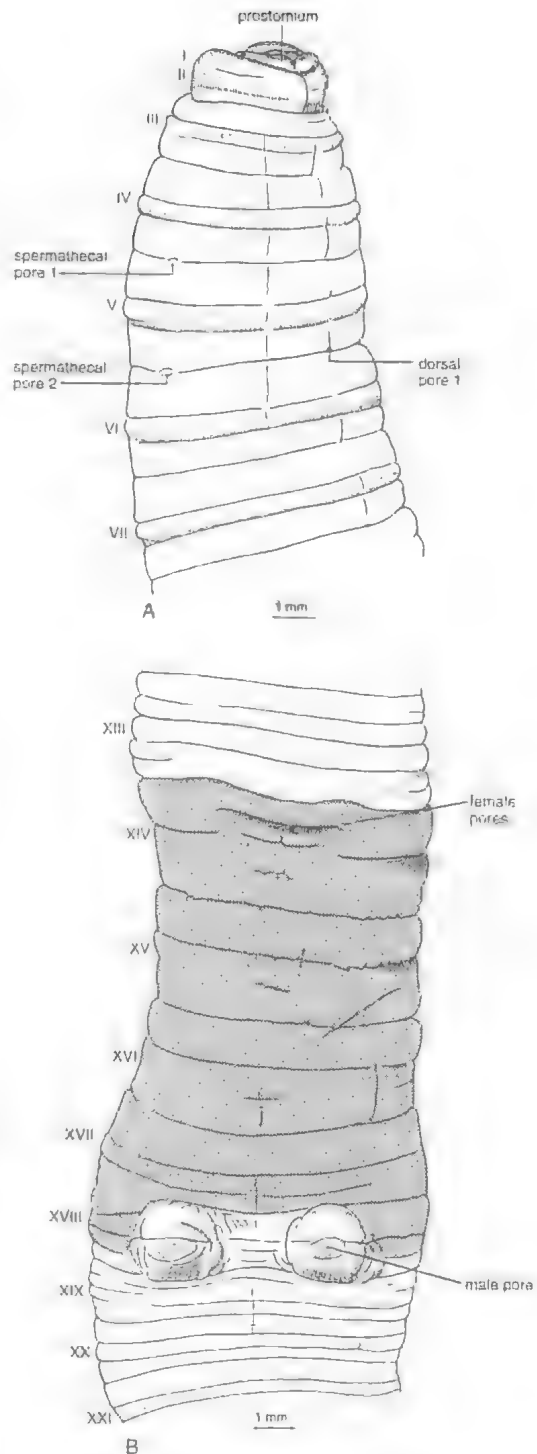


FIG. 7. *Terrisswalkerius windsori* sp. nov., Holotype, QMG211466. A, dorsolateral view of anterior end. B, ventral view of male genital field.

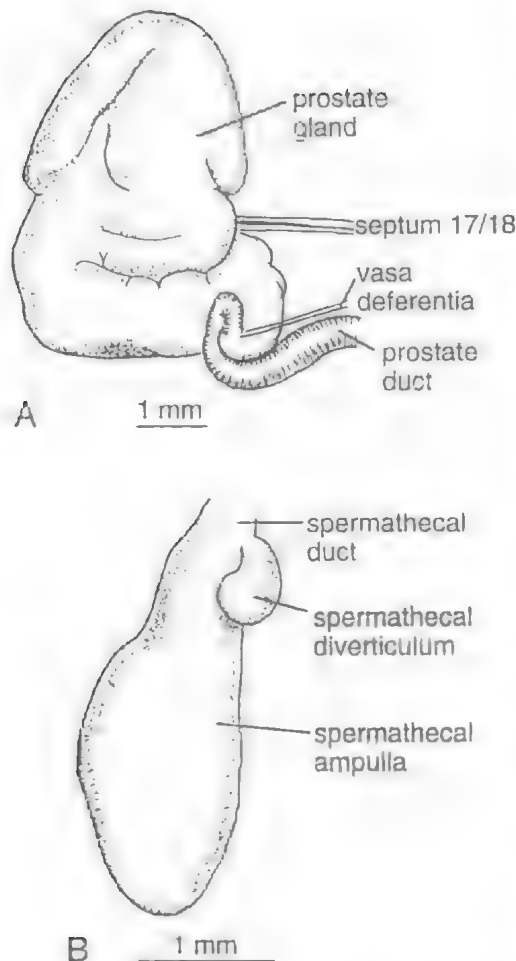


FIG. 8. *Terrisswalkerius windsori* sp. nov., Holotype, QMG211466. A, right prostate. B, right posterior spermatheca.

globose but its anterior limit straight sided. Calcareous glands and oesophageal dilatations absent. Intestinal origin XVII. Typhlosole absent. Nephridia stomate, vesiculate holonephridia; Those in II large and very complexly tufted and with elongate bladder opening anteriorly near the midventral line; those in III and IV with bladders apposed to those of II but progressively more dorsal and, though tufted, smaller; those in V and VI with very long ectally tapering bladders, lacking diverticula, discharging approximately in line with the spermathecae and compactly tufted; the duct joins the bladder slightly subterminally in anterior segments but with no true diverticulum. Nephridia not visible in VII - XI; in XII with very

elongate bladder; by XV bladders are sessile subspheroidal, with duct entering subterminally. Large, nacreous, free male funnels in X and XI. Seminal vesicles large and racemose on the anterior face of XII and small and smoothly subspheroidal (pseudovesicles?) on anterior face of X. Ovaries delicate laminae of oocytes, in XIII. Prostates tubuloracemose; in the holotype dorsoventrally depressed thick plates which are resolvable into a tortuous structure; duct coiled and muscular, joined entally by the vasa deferentia; in one paratype, however, the prostates projecting at the amputated end are coiled tubes much as in *T. nashi*. Spermathecae 2 pairs, each with elongate ovoid ampulla the tapering distal portion of which is joined near its ectal end by a clavate diverticulum which is about one fourth of the length of the spermatheca and ectal to which is a very short common duct.

ETYMOLOGY

For the Windsor Tableland.

REMARKS

Only *Terrisswalkerius montislewisi* resembles *T. windsori* in having (as a variant in the former) two pairs of spermathecal pores but *T. windsori* is unique in the genus in the dorsolateral location of the pores and in presence of the first pair in intersegmental furrow 4/5 rather than 5/6.

In view of variation from two to three pairs of spermathecae in *T. lewisi*, it is appropriate to make comparison between *T. windsori* and species with three pairs of pores. Of these, both *T. raveni* and *T. barronensis* have spermathecal pores far separated from the ventral midline (in *d* or *d-e* lines) but only *T. raveni* has short spermathecal diverticula as in *T. windsori*. It also has large male porophores and the intestinal origin in XVII as in *T. windsori* but it differs in having more numerous setae, in location of the last hearts in XII (not XIII), in possessing true nephridial diverticula, and four pairs of seminal vesicles. The male porophores of *T. windsori* are also distinctive in form.

Observed variation in the appearance of the prostates, from a plate-like, albeit composite, mass to a coiled tubular form is unusual and suggests that the appearance of prostate glands is considerably influenced by the conditions of fixation.

Tribe DICHOGASTRINI
Cryptodrilus bunyaensis sp. nov.
 (Figs 9, 10)

MATERIAL EXAMINED

HOLOTYPE: QMG211508.

PARATYPES: 10 examined for distribution of genital markings, QMG211509; 63 additional paratypes, QMG211510. All types clitellate. All specimens from 26°57'S, 151°35'E, red soil under leaf litter in *Araucaria bidwilli* forest, Bunya Mts. National Park, Qld. Collected B.G.M. Jamieson, E. Bradbury, 17 Mar. 1971.

DESCRIPTION

Length 76mm, width (midclitellar) 3.5mm. Segments 185 (Holotype). Colour pigmented light brown with dark reddish brown clitellum, in ethanol. Prostomium very small, tanylobous, though crossed by a transverse furrow behind its midlength; peristomium very short and prostomium not or only partly visible dorsally; peristomium not demarcated from first setigerous segment (II) ventrally and only by an indistinct transverse groove dorsally to which the dorsal tongue of the prostomium extends. First dorsal pore 9/10 but dorsal pores indistinct. Setae 8 per segment, black and distinctly visible, in regular longitudinal rows; *ab* moderately closely paired but *cd* widely spaced, *c* being lateral and *d* far dorsal; *aa:ab:bc:cd:dd* = 2.7: 1.0: 3.4: 2.3: 5.1; or 12.7:4.7:16.0:10.8:24%. Clitellum saddle-shaped, in XIII-XVIII: intersegmental furrows 12/13 and 18/19 well developed but the intervening intersegments indicated weakly and ventrally only. Male pores in XVIII; minute pores with thin lips, in *ab*, these setae being absent, each pore in a glandular depression the slightly raised oval margins of which extend median of *a* lines and lateral of *b* lines. Genital markings paired "eye-like" medianly conjoined oval markings with pre-setal porelike depression in *ab*, the markings situated in XI, XII, XV-XVII, XX and XXI; the posterior limit of each marking in XI, XII XX and XXI shortly behind setae *ab*; but in XV, XVI and XVII, like the field in XVIII, reaching the posterior border of the segment. Ten paratypes were examined for distribution of genital markings; they resembled the holotype exactly with the exception that one specimen lacked the markings in XI and XII; one lacked those in XII; and all but three specimens lacked the markings in XXI; of the 10 paratypes, in one the marking in XI was unilateral left, and in another the marking in XXI was unilateral right. Female pores minute each with a weak oval field, far apart, shortly an-

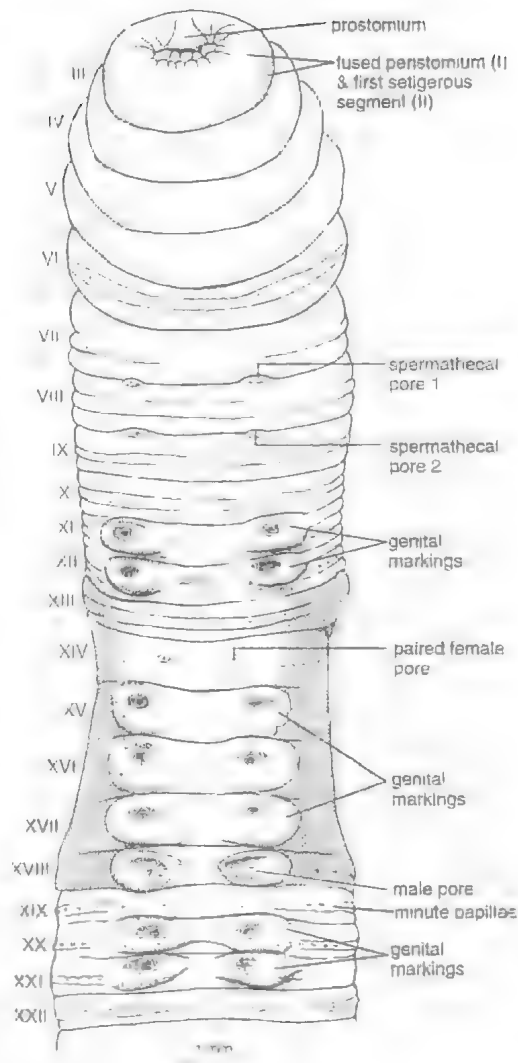


FIG. 9. *Cryptodrilus bunyaensis* sp. nov., Holotype, QMG211508. Ventral view of forebody and clitellar region.

teromedian of setae *a* of XIV. Spermathecal pores 2 pairs, minute and indistinct, on small oval papillae at the anterior margins of VIII and IX which deflect intersegmental furrows 7/8 and 8/9 anteriorly in their vicinity.

Dorsal blood vessel continuous onto the pharynx. Last hearts in XII. Gizzard large, broad, cylindroid in V, with conspicuous anterior rim which is continuous with a thinner walled proventriculus lying in IV. Oesophagus with paired lateral dilations in VIII-XIV; those in XXIV

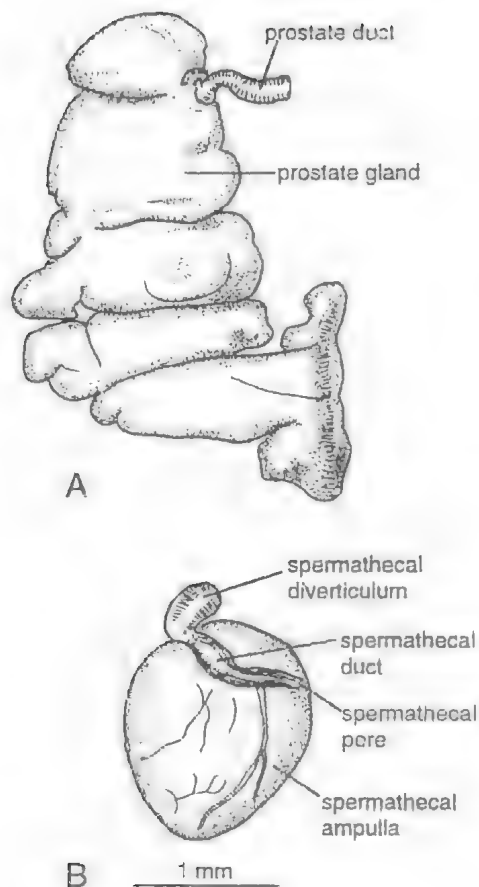


FIG. 10. *Cryptodrilus bunyaensis* sp. nov., Holotype, QMG211508. A, ventral view of right prostate gland. B, ventral view of right spermatheca.

forming true extramural calciferous glands with internal lamellae; but only those of XII and XIII constricted off from the oesophagus; best developed in XIII where they are reniform. Intestinal origin abrupt, in XVI. Typhlosole absent. Nephridia in the anteriormost segments several conorted, and sometimes almost tufted, large meronephridia on each side but none found to be enteronephric. In the anterior intestinal region, shortly behind the prostates, three large megameronephridia on each side with slender exonephric ducts entering the body wall in setal lines *b*, *bc* (nearer *c*) and in *d*; caudally, the largest nephridium, discharging in *b* line, has a large preseptal funnel and is thus a stomate megameronephridium; no enteronephry demon-

strable. Holandric; testes and funnels not certainly demonstrated but free coagulum (putative sperm masses) in X and XI; and seminal vesicles, racemose with many berry-like loculi, in IX, XI and XII. Ovaries large masses of many oocytes, in XIII. Prostates elongated through several segments, broad and racemose; each with a slender convoluted duct about one fifth the length of the gland. Spermathecae 2 pairs, in VIII and IX; each with a large ovoid ampulla, a slender duct a little more than half the length of the ampulla, and a short, digitiform diverticulum, with spermatozoal iridescence, sessile at the junction of the two.

ETYMOLOGY

For the Bunya Mountains.

REMARKS

Cryptodrilus bunyanensis resembles *C. mediocris* Fletcher, from New South Wales, in loss of the intersegmental furrow between the peristomium and the first setigerous segment. Although this feature occurs in other genera (e.g. *Digaster*), it is rare and its presence in the two *Cryptodrilus* species gives some additional support to inclusion of the new species in the genus. It differs from *C. mediocris* in lacking nephridial bladders and from all species of the genus in the distinctive arrangement of genital markings.

Digaster lingi sp. nov. (Figs 11, 12)

MATERIAL EXAMINED

HOLOTYPE: QMG211484 (clitellate). From ca. 28°12'S, 153°11'E., Binna Burra, Qld., in rainforest. Collected E. Ling, M. Cunningham.

DESCRIPTION

Length (posterior amputee). Width (midclitellar) 7.2mm. Pigmentless in life. Prostomium tan-ylabous, with broad, posteriorly narrowing dorsal tongue. Peristomium short; not canaliculate. Forebody segments, at least from VI posteriorly, strongly biannulate; traversed by a presetal groove which is almost as pronounced as the deep intersegmental furrow; postclitellar segments at first biannulate, becoming weakly triannulate. First dorsal pore 4/5. Setae small and, especially the lateral pair, difficult to discern; both pairs moderately closely paired; in XIV, *aa:ab:bc:cd* = 2:1:2.8:1. Clitellum annular, strongly protuberant, but weaker midventrally; dorsally XIII-XVIII, ventrally XIII-2/3XVIII; setae visible, intersegmental furrows largely obscured; dorsal

pores suppressed. Male pores a pair of thin, transversely extensive slits in XVIII on a pair of low but large, transversely oval papillae which extend from *a* lines into *bc* (relative to adjacent segments; setae *a* and *b* absent in this segment. Genital markings: a slightly tumid elliptical area fills the region between the male porophores from the posterior limit of the setal annulus of XVII to the anterior limit of that of XIX interrupting the clitellum ventrally; it bears a pair of well defined oval depressions at the site of intersegmental furrow 18/19 which is suppressed on the tumid area. Female pores inconspicuous, anteromedian to setae *a* of XIV, in a transverse slit. Spermathecal pores 2 pairs, in intersegmental furrows 7/8 and 8/9, in *a* lines, small, and visible only when the intersegment is parted.

Septa 7/8-11/12 very strongly thickened, especially 8/9-10/11. Dorsal blood vessel single, continuous onto the pharynx. Last hearts very large, in XII; those in X-XII latero-oesophageal but only those in XII shown to have (thin) connectives to the dorsal vessel. Two moderately large, subspheroidal muscular gizzards, in VI and VII, separated by a thin-walled proventriculus-like region. Oesophagus vascular but lacking calciferous glands; strongly dilated and intestine-like in XIV. Intestinal origin XVIII. Nephridia (caudal region of body not available) stomate, avesciculate micromeronephridia; in the vicinity of the prostates on each side there is a ventral convoluted nephridial mass lateral to which are about 10 small nephridia in transverse single file, each with a long, thin ectal duct, egress of the ducts at the body wall scattered between the anterior and posterior limits of the segment. Testes? and nacreous funnels in X and XI, the posterior pair better developed. Seminal vesicles racemose, in IX and XII, the latter pair the larger. Ovaries represented by many thin, empty strands. Prostates large racemose, flattened discs, each with a short muscular ectal duct, in XVIII. Spermathecae 2 pairs, in VIII and IX, each with an ovoid ampulla and a shorter duct which is joined ectally by a small, rounded and apparently pluriloculate diverticulum.

ETYMOLOGY

For Edmund Ling who collected the specimen.

REMARKS

Three species of *Digaster*, *D. gwongorellae*, *D. minor*, and *D. moretonensis*, in addition to *D. lingi*, have a midventral circular, oval or almost bifid pad or tumid area on XVIII between or

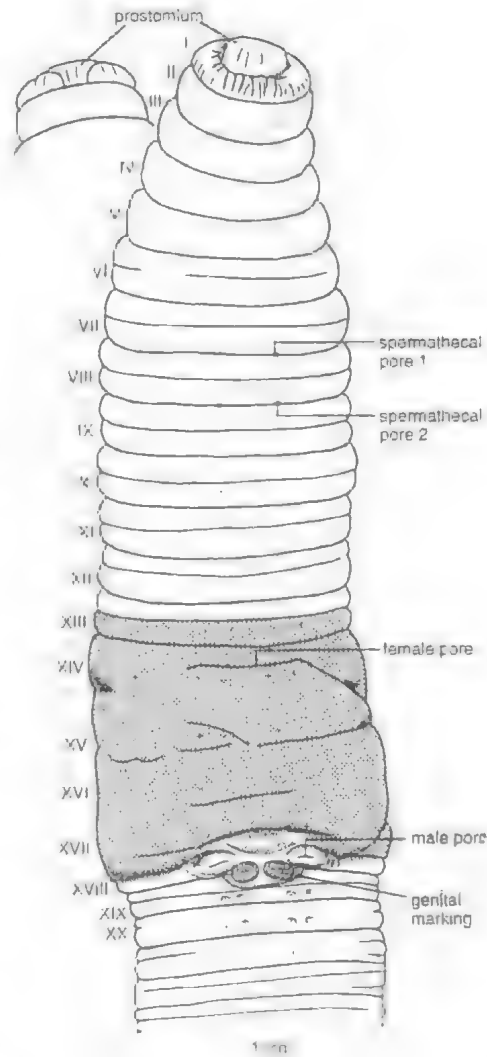


FIG. 11. *Digaster lingi* sp. nov., Holotype, QMG211484. A, dorsal view of anterior end showing prostomium. B, ventral view of forebody and clitellar region.

including the male pores. *D. lingi* differs from all three in having genital markings at 18/19 and differs further from *D. gwongorellae* and *D. moretonensis* in having paired female pores. *D. lingi* also differs from *D. minor* in having the lateral setal couples about as wide as, rather than twice as wide as, the ventral couples. *D. lingi* further differs from *D. moretonensis*, among other respects, in the absence of genital markings on segments XIX to XXIII and the much shorter

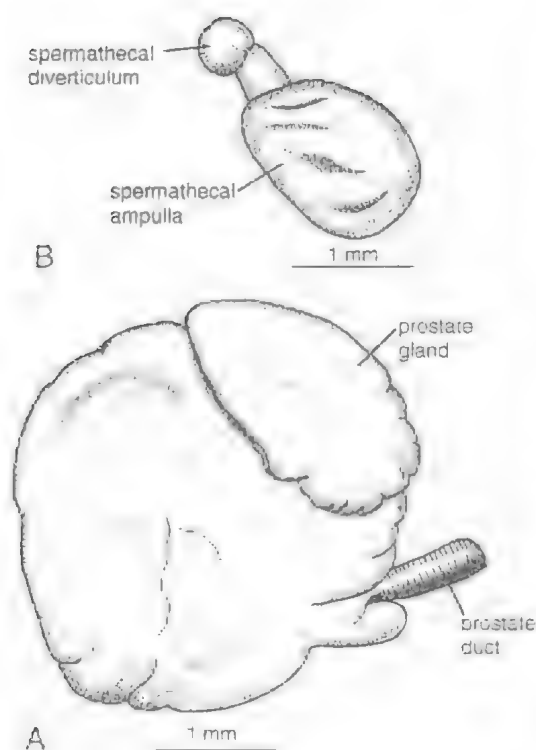


FIG. 12. *Digaster lingi* sp. nov., Holotype, QMG211484. A, left prostate gland. B, right posterior spermatheca.

clitellum which extends to XX in *D. moretonensis*.

***Digaster moretonensis* sp. nov.**
(Figs 13)

MATERIAL EXAMINED

HOLOTYPE: QMGH1445.

PARATYPE: QMGH1444. Both from 27°11'S, 153°24'E, Moreton Island, Eager's Swamp, pitfall trap, Qld. Collected Queensland Museum Party, 22 Sep 1982.

DESCRIPTION

Length 190 (P)-205 (H) mm, width 9.8 mm (H)-11 mm (P). Segments 218 (H). Pigmentless in alcohol with light chocolate brown clitellum. Prostomium prolobous; it and the peristomium with several parallel longitudinal dorsal furrows. First dorsal pore well developed, at 5/6 (H, P). Setae minute; in holotype and paratype arrangement not certainly determinable in the forebody; but shortly behind the male pores four pairs, *ab*

closely paired; *cd* slightly more widely paired; *c* and especially *d* lines irregular; $dd = 0.5u$. Clitellum from presetal XIII-XX ventrally, to XXI dorsally; a posteriorly widening median strip is acitellate in XVII posteriad and is pale and possibly interrupted in XV-XVI, and paler, though complete, in XIV, annular but weaker and less pigmented in XIII. Male pores a pair, minute, lacking definite porophores, equatorial in XVIII, in *ab*, in a non-glandular patch which extends laterally beyond *b* lines relative to adjacent segments, setae *ab* being absent in this segment. Accessory genital markings (H only) midventral pale brown transverse oval patches, including the ventral pairs of setae, in XX-XXIII, best developed in their postsetal portions. Female pore single, slightly displaced to the right (H) or midventral (P). A midventral pore presetal in XIII (H) also, in a glandular craterlike elliptical field (indicated as a genital marking in Fig. 13A). Spermathecal pores 2 pairs, in 7/8 and 8/9, very slightly median of *a* lines; those in 8/9 2.0 mm apart.

Dorsal blood vessel single, continuous onto the pharynx. Last hearts in XII; those in X-XII large, tortuous and latero-oesophageal. Two very large globular gizzards, in VI and VII, with a very short non-muscular zone between; calciferous glands absent; intestine commencing with abrupt expansion in XVIII but septum 17/18 pressed forward into XVII. Small, nacreous, free sperm funnels in X and XI; small, compact racemose seminal vesicles in XI and XII. Nephridia numerous avascular micromeronephridia observed in midbody in segments in the vicinity of prostates. No buccopharyngeal enteronephry observed. Caudally, the medianmost nephridium greatly enlarged as a megameronephridium with preseptal funnel. Ovaries with many chains of small oocytes, and large funnels, in XIII. Ovisacs absent. Prostates racemose, each a rectangular lobe in XVIII with its anterior (ental) end reaching posterior XVI. Duct almost as long as the gland, curved mediad and widened ectally. The duct with three median diverticula of which the largest is about half the length of the duct, the shortest (anterior) almost subspheroidal, and the third intermediate in length. Vasa deferentia not observed. Penial setae absent. Spermathecae 2 pairs, in VIII and IX, each with an ovoid ampulla, broad, poorly demarcated ectally tapering duct, and multiloculate diverticulum on the dorsoanterior aspect of the ectal end of the duct.

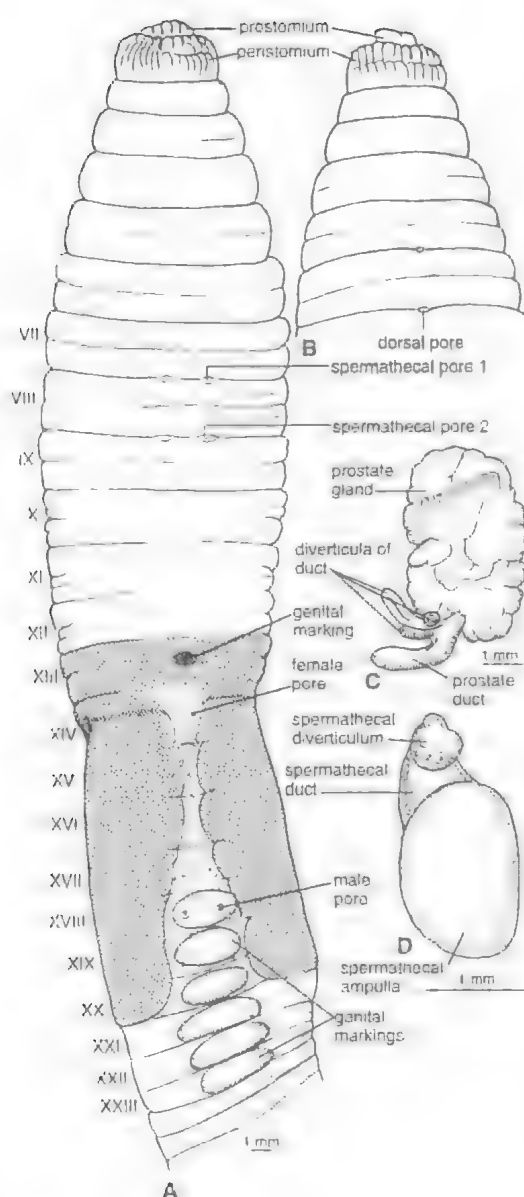


FIG. 13. *Digaster moretonensis* sp. nov., Holotype, QMGH1445. A, ventral view of forebody and clitellar region. B, dorsal view of anterior end. C, right prostate gland. D, right posterior spermatheca.

ETYMOLOGY

Named after Moreton Island, the type-locality.

REMARKS

D. moretonensis is distinguished from other species of the genus by a combination of charac-

ters: the presence of midventral segmental genital markings in XVIII to XXIII, the long clitellum, extending to XX, and the unpaired, midventral or unilateral female pore. The diverticula of the prostate ducts are unknown in other oligochaetes. They possibly represent branches of the duct typical of racemose prostates, which have not developed glandular coats.

Tribe MEGASCOLECINI *Oreoscolex retrocystis* sp. nov. (Figs 14A, 15)

MATERIAL EXAMINED

HOLOTYPE: QMG211416.

PARATYPES: QMG211417-211421, all types from S.E., Galston Gorge near Sydney, N.S.W., in dark sandy soil bordered above and at the sides by large rocks, about 20 feet above the river shortly below the wooden bridge. Collected B.G.M. Jamieson, 23 May 1962.

DESCRIPTION

Lengths (3 intact paratypes) 75-86mm, mean 79.7mm. Width (segment XIV in holotype and 3 paratypes) 2.4-3.1, mean 2.6mm. Segments 162-172, mean of 3=168. Pigmentless in ethanol. Prostomium very small, closed, epilobous 1/4 to <1/2 but may be retracted into the mouth so as to appear probolous. First dorsal pore 10/11 (holotype and 3 paratypes) or 11/12 (1 paratype). Setae 8 per segment, in regular longitudinal rows; small but distinct on well demarcated setal annuli; in XII (H) $aa:ab:bc:cd:dd=3.5:1:3.1:2.3:9.4$; or $13.5:3.9:12.2:8.9:36.6\%$. Clitellum not developed in the holotype; in three paratypes, represented by slight annular tumescence and partial occlusion of dorsal pores in XIV-XVII, and dorsally in XIII; intersegmental furrows clearly defined and, in view of the maturity of the specimens, probably never obliterated by the clitellum. Male pores minute on a pair of very small papillae on XVIII, at the site of the absent setae *a*. In the holotype and the, fully mature, paratypes (QMG211417-21), accessory genital markings are very large sharply defined, raised subcircular intersegmental markings, with pore-like centres in *ab* in 16/17 and 19/20. In 16/17 they extend to the setal annuli of the two adjacent segments, where they are paired or (H and Paratype QMG211417) unilateral, right. In 19/20, they are paired (H and paratype QMG211417) or (paratypes QMG211418, 21) unilateral, right. In two specimens they are absent from 19/20 (paratypes QMG211419 and 20). The male papillae lie at the lateral extremity of a deep depres-

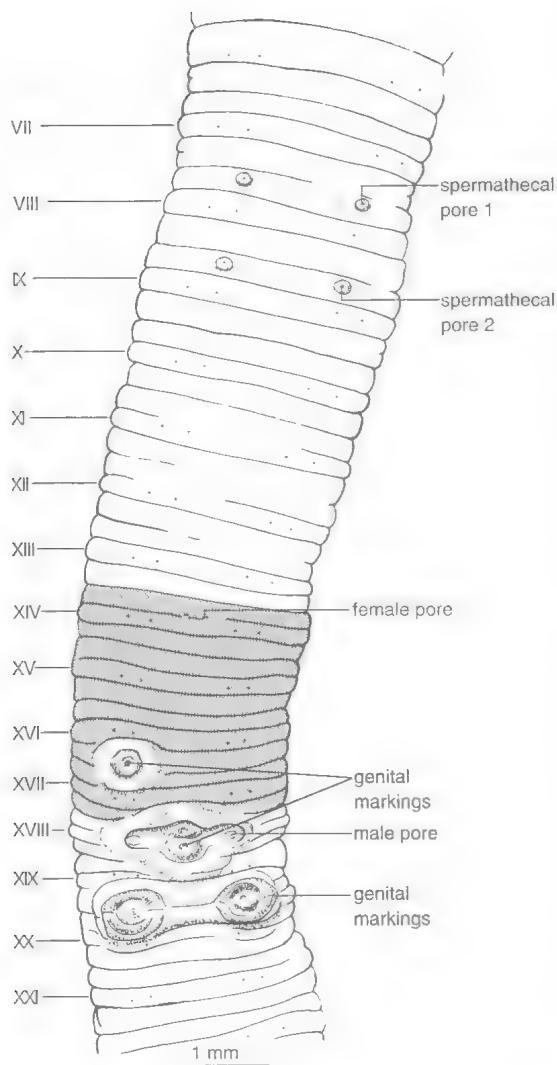


FIG. 14. *Oreoscolex retrocystis* sp. nov., Holotype, QMG211416. A, ventral surface, from the spermathecal to the male genital regions.

sion, with the form of a wide partly open mouth, the tumid lips of which are sharply defined at the inner margin, which forms parentheses closely lateral to the male papillae, and in the midline circumscribes a large median papilla and (visible in the holotype only) in front of this a small median papilla; the tumid lips extending in the midline to the setal annuli of segments XVII and XIX. Female pores minute, less than one third *aa* apart, in an inconspicuous transverse slit which coincides with the furrow anteriorly limiting the setal annulus of XIV (holotype, 1 paratype) or

small gaping slits slightly anterior to the setal annulus on a common oval tumid area (3 paratypes). Spermathecal pores 2 pairs, on well marked small, hemispheroidal papillae anteriorly in VIII and IX, nearer 7/8 and 8/9 than they are to the setal annulus, in *a* lines (holotype and 4 paratypes).

The holotype and paratype QMG211421 were dissected for internal anatomy. Dorsal blood vessel single, continuous onto the pharynx. Last hearts in XIII; hearts in X-XIII each arising in common with a latero-oesophageal vessel from a short common lateral vessel from the dorsal vessel. No hearts recognized in VIII and IX in which the latero-oesophageal vessel encircling the calciferous glands is also much less developed than in X-XIII. Gizzard very large, firmly muscular, in V, cylindrical but slightly tapering posteriorly, deflecting septa 5/6 and 6/7 posteriorly. Calciferous glands very large, paired in VIII-XIII (6 pairs), each reniform and well demarcated from the oesophagus which it joins only at its hilus. Intestine commencing with abrupt expansion in XVI. Typhlosole dorsal, low in XVI, well developed in XVII and by XVIII becoming a very large inverted T-shaped structure. Nephridia meronephridia; large tufts anterior to the gizzard but lying in V discharge by wide ducts into the pharynx; in the oesophageal region and anterior intestinal region many stomate avesculate micromeronephridia; caudally with several pre-septal nephrostomes and a very conspicuous longitudinal ureter which is situated dorsally to the dorsal blood vessel and continues posteriorly; it is not traceable to its termination in the holotype which is a posterior amputee but in the paratype appears to enter the intestine about 25 segments from the anus. Iridescent sperm funnels in X and XI; seminal vesicles compact and racemose, in XII only. Ovaries small, palmate, in XIV. Prostates elongate racemose, the gland in XVIII and XIX, with distally widening muscular curved or straight duct; vas deferens running up the duct to join the junction of gland and duct. A large subspheroidal firm mass, presumably glandular or glandulomuscular, corresponding with each of the paired accessory genital markings and with the large midventral marking. Spermathecae 2 pairs, in VIII and IX; each with a narrow pyriform ampulla, a short, digitiform diverticulum (uninseminated in the holotype; with iridescent sperm masses in the paratype), and a moderately slender fairly muscular duct.

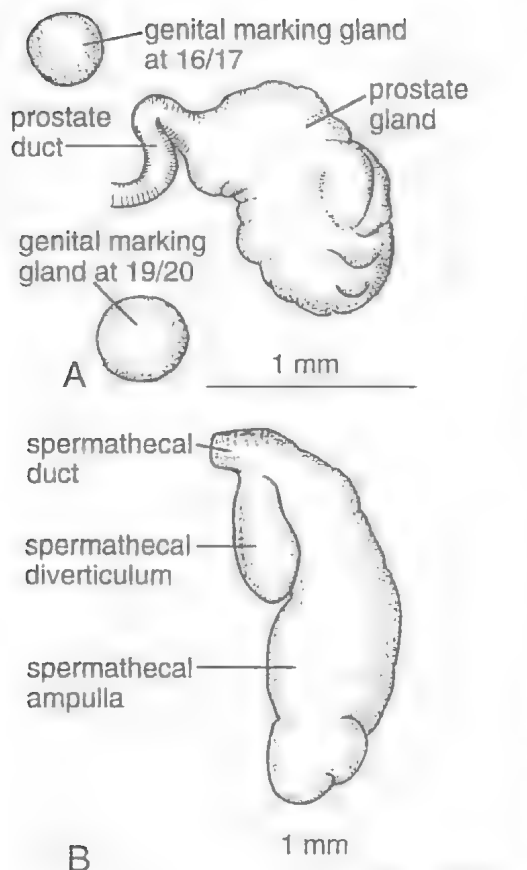


FIG. 15. *Oreoscolex retrocystis* sp. nov., Holotype, QMG211416. A, right prostate. B, ventral view of right spermatheca of IX.

ETYMOLOGY

From *retro*, backwards, and *cyst*, a thin-walled hollow organ, alluding to the location of the spermathecal pores behind rather than in the intersegmental furrows.

REMARKS

Oreoscolex retrocystis resembles *O. saccarius*, in addition to their general *Oreoscolex* characters, in having the first dorsal pore in 10/11; intersegmental accessory genital markings; 2 pairs of spermathecal pores on small protuberances; 6 pairs of reniform calciferous glands, in VIII–XIII; and last hearts in XIII. It agrees with the type species, *O. imparicystis*, in having segmentally

located spermathecal pores (there posterior in VII and VIII) and in having seminal vesicles in XII only. It differs from all other *Oreoscolex* species, and, indeed, all known oligochaetes, in the configuration of the genital markings.

Propheretima gen. nov.

TYPE SPECIES

Propheretima eungella sp. nov.

DIAGNOSIS

Perichaetine; setae numerous per segment; a few present between the male pores. Female pore single, midventral (or sometimes, *P. hugalli*, paired but very close together?). Clitellum limited to XIV–XVI. Gizzard in V. Calciferous glands present or absent, Intestinal caeca absent. Testes in X and XI.

DESCRIPTION

Peristomium ventrally bisected or not. Dorsal pores present. Setae numerous in setigerous segments; a few present between the male pores. Clitellum annular, XIV–XVI. Male pores in XVIII; porophores typically but not always preceded and succeeded by an intrasegmental crescentic groove. Intrasegmental accessory genital markings present or (if immature?) absent. Female pore unpaired (typically) or paired. Dorsal blood vessel single. Last hearts in XII or XIII. Gizzard in V. Calciferous glands present or absent. Meronephric, typically with intrasegmental funnels. Enteronephry unknown. Holandric; seminal vesicles in IX and XII or IX, X, XI and XII. Prostates tubuloracemose or racemose (single lobed). Ovaries in XIII. Spermathecae each with a single diverticulum.

ETYMOLOGY

Propheretima, referring to an apparent plesiomorphic relationship to *Pheretima* sensu lato.

OTHER SPECIES

Propheretima (= *Megascolex*) *fuscus* (Michaelsen, 1916). Queensland.

Propheretima hugalli sp. nov. New South Wales.

SPECIES INCERTAE SEDIS

Propheretima (= *Megascolex*) *heterochaeta*. Queensland.

Propheretima (= *Perichaeta*) *newcombei* (Beddard, 1887). Queensland.

REMARKS

Jamieson (1977) drew attention to the likelihood that the great oriental assemblage of species in the genus *Pheretima* sensu lato, which now includes the Australo-Papuan genus *Begemius* Easton, had its ancestry in Australia. It was suggested that the Australian genus *Spenceriella* was the nearest known extant relative of *Pheretima*. The species here placed in the new genus *Propheretima* fall within the definition of *Spenceriella* given by Jamieson (1972) and Jamieson & Wampler (1979). However, they are distinguished from other species placed in *Spenceriella* by a combination of characters: presence of setae between the male pores, restriction of the clitellum to segments XIV-XVI, and, typically, a single female pore, all of which are features of *Pheretima* sensu lato. They differ from *Pheretima* sensu lato in having the gizzard in segment V, not the apomorphic location in VIII, and in at least as many features as separate the various genera now recognized within that assemblage. Within *Propheretima*, the type species, *Propheretima eungella* and *P. fuscus* appear to be closely related, sharing crescentic grooves which bound the male porophores anteriorly and posteriorly.

P. tugalli is placed in *Propheretima* because it has the clitellum restricted to XIV-XVI and setae, albeit only setae *a* and *b*, between the male pores. It differs from *P. eungella* in apparent pairing of the female pores, though that they are not medianly fused requires confirmation from further material.

Placement of *P. heterochaeta* and *P. newcombei* in *Propheretima* is uncertain. *P. newcombei* is included because it has a single female pore and appears from an illustration by Beddard (1887) to have setae between the male pores. However, if Beddard's account is correct, it is unique in the Megascolecidae in location of the gizzard in IV, V and VI which retain their intervening, rather delicate septa. The species is inadequately described, the types have been lost and the author has been unable to collect it in the type or other localities. Gates (1965) synonymy of the New Zealand *Megascolex laingi* Benham in *M. newcombei* is not here accepted.

P. heterochaeta is here included in *Propheretima* chiefly because Michaelsen (1916) considered this species to be near *Megascolex* (here *Propheretima*) *newcombei* which differed in the form of the accessory genital markings. Inclusion in *Spenceriella* is contraindicated by the large setal numbers (68 in segment 50), inter-

line beginning in XVII (XV or XVI in *Spenceriella*), and location of seminal vesicles in X and XI (in addition to IX and XII). Details of the meronephridia are not known. Because of the immature state of the types, the generic placement of this species, and indeed its specific characteristics, remain uncertain.

KEY TO THE SPECIES OF *PROPHERETIMA*

1. Each male porophore immediately preceded and succeeded by an intrasegmental crescentic groove 2
Each male porophore not immediately preceded and succeeded by an intrasegmental crescentic groove 3
2. Genital markings on X, XVII-XX. Three pairs of well developed sessile calciferous glands in X-XIII *P. eungella*
No preclitellar genital markings (immature?). [A slightly raised transverse field may be present midventrally in XVIII, and also posteriorly in XVII and anteriorly in XIX]. Calciferous glands absent *P. fuscus*
3. Each male porophore preceded and succeeded, at the intersegment and slightly more medianly, by a puckered pit. A pair of transverse pads equatorially in X with a small presetal, pore-like depression *P. tugalli*
Each male porophore not preceded and succeeded by a puckered intersegmental pit. Genital markings not as 3(1) 4
4. Prostomium epilobous. Genital markings not definitely developed *P. heterochaeta*
Prostomium probolous. Preclitellar genital markings present to as far forward as VII. [Genital markings very variable. When most numerous: segment XIII with a single, midventral papilla; XI and XII each with three papillae close together, one median and one on each side of this; X with four papillae, of which the middle ones correspond in position to the median papillae of the two succeeding segments; IX with a single papilla, corresponding in position to the outermost right hand one of segment X, the others being indistinct; VII and VIII each with a single median papilla] *P. newcombei*

***Propheretima eungella* sp. nov.**
(Figs 16, 17)

MATERIAL EXAMINED

HOLOTYPE: QMG211434 (clitellate). All specimens from 21°08'S, 148°30'E, Eungella National Park, Palm circuit, Qld., in a rotting log. Collectors A. Postle and G. Dyne, 13 Jun. 1974-Qld.

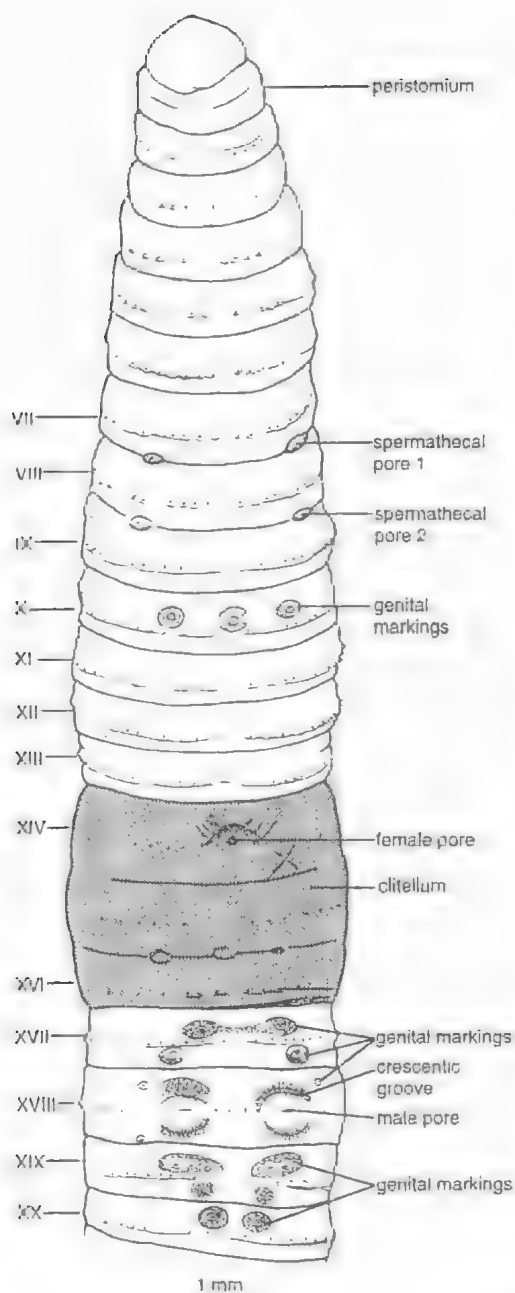


FIG. 16. *Propheretima eungella* sp. nov., Holotype, QMG211434. Forebody and clitellar region.

DESCRIPTION

Length 61mm, width 3.7mm, segments 93. Colour in ethanol dorsally dark steel grey; pale ventrally; clitellum buff. Prostomium epilobous 1/2. Peristomium not ventrally bisected. First dorsal pore 4/5. Setae in XII, 34;

$aa:ab:bc:cd:yz:zz = 1.8:1.0:0.8:0.8:1.6:2.8$; dorsal break small but appreciable in the forebody, caudally not appreciable and ventral break scarcely greater than adjacent setal intervals; about 12 segments from the posterior extremity 60 setae per segment; a few present between the male pores. Clitellum annular, XIV-XVI. Male pores narrow elongate slits on two large, transversely oval porophores in XVIII, with centres in *cd*, in the setal arc, each porophore bordered anteriorly and posteriorly by a crescentic glandular depression. Accessory genital markings: eye-like markings consisting of a central small transversely oval papilla and a dark glandular field with a white rim, not noticeably raised, a pair presetally in *cd* and one median in X; in XVII a presetal, medianly conjoined pair with centres just lateral of *b*, and a postsetal pair in *d* lines; in XVIII, minute markings anterolateral and posterolateral to the male porophores, approximately in setal lines 6-7 relative to segment XIX; in XIX a glandular area presetal from *a* to *e* lines, each with two small eyelike markings of which the lateral is the larger; in XX a presetal pair with centres in *b* lines. Female pore unpaired, mid-ventral and presetal in XIV. Spermathecal pores 2 pairs, in intersegmental furrows 7/8 and 8/9, in setal lines 5-6, on small papillae.

Dorsal blood vessel single. Last hearts in XII. A large, moderately compressible gizzard in V. Three pairs of well defined subspheroidal calciferous glands in X, XI and XII, each sessile but well constricted off from the oesophagus; the lumen of each gland with many radial vascularized laminae almost meeting centrally. Intestine commencing with abrupt expansion at the anterior septum of XVI. Loose aggregates of meronephridia in the pharyngeal region send a large duct forwards to the vicinity of the peristomium but no enteronephry detected. Caudally with 10 or more meronephridia on each side of which some at least have a long-stalked, intrasegmental, posteriorly directed minute funnel. A single, larger preseptal funnel present on each side medianly; no enteronephry demonstrated. Free testes and iridescent funnels in X and XI; very large racemose, much subdivided seminal vesicles with large loculi and clusters of many minute spheroidal bodies, paired in IX and XII. Prostates tubuloracemose, restricted to XVIII; superficially racemose lobes but resolvable into a flattened S-shaped structure with three continuous adpressed sections; each gland with a stout looped muscular duct. Ovaries a pair in XIII, each a large mass of many oocytes with multiple stalks

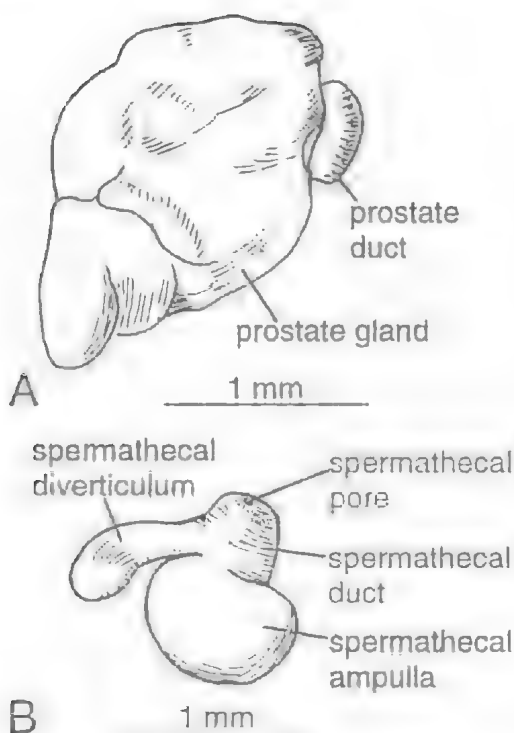


FIG. 17. *Propheretima eungella* sp. nov., Holotype, QMG211434. A, right prostate gland. B, right posterior spermatheca.

to the anterior septum; a pair of large funnels on the posterior septum. Spermathecae 2 pairs in VIII and IX, each discharging at the anterior intersegment; each with a large transversely ovoid ampulla, a bulbous inseminated diverticulum of approximately equal length, and a short wide duct.

ETYMOLOGY

From Eungella National Park.

REMARKS

Propheretima eungella resembles only *P. fuscus*, in the genus, in having a crescentic groove bordering each male porophore anteriorly and posteriorly but differs from the latter species, and all other members of the genus, in having genital markings on X, XVII-XX and three pairs of well developed sessile calciferous glands in X-XIII.

Propheretima hugalli sp. nov. (Figs 18, 19)

MATERIAL EXAMINED

HOLOTYPE: QMG211452. From c. 28°49'S, 153°16'E, Lismore, Boat Harbour, NSW. Collector A. Hugall. 12 Aug. 1994.

DESCRIPTION

Length unknown, width (midclitellar) 2.4 mm, number of segments unknown. Colour in ethanol pinkish purple, paler ventrally in the postclitellar region. Prostomium closed epilobous 1/3. Peristomium very short, bisected ventrally. Body not canaliculate. First dorsal pore 6/7. Setae perichaetine, 30 in XII; in the forebody, dorsal (zz) and ventral (aa) breaks small but just appreciable relative to adjacent intervals; ventral break wider behind the clitellum; caudally zz and aa remain narrow and z line is irregular. Setae a and b present between the male porophores. Clitellum annular, XIV-XVI; strongly demarcated and protuberant; setae, dorsal pores and intersegments obscured. Male pores in c lines towards the median aspect of a pair of large oval porophores which are well demarcated medianly but not laterally and which almost fill XVIII anteroposteriorly. Each porophore preceded and succeeded, slightly more medianly, by a roughly oval depression, in posterior XVII and anterior XIX, with puckered anterior or posterior margins respectively; these depressed genital markings continuous with a relatively depressed area between the porophores. Other genital markings consist of a pair of poorly defined transverse pads equatorially in X which fill the segment longitudinally; each with a small pore-like depression in the setal arc, in c lines. A small transverse elevation in XIV appears to bear a pair of female pores very close together but pairing requires confirmation. Spermathecal pores 2 pairs, in 7/8 and 8/9, only the posterior left pore visible, in d line.

Dorsal blood vessel single. Last hearts in XII. Gizzard small, soft, virtually vestigial, in V with slight muscular sheen which is also seen on the slightly narrower oesophagus in IV and anterior VI. Oesophagus also whitish in VII; vascularized and intersegmentally constricted in VIII to XIII; in XI, XII and XIII with a dorsal longitudinal groove giving some appearance of extramural calciferous glands and in these segments with high internal rugae but not constricted off from the oesophageal lumen. Intestine commencing in XVI. Nephridia aversiculate micromeronephridia; no funnels definitely present in the forebody and clitellar regions; some loose tufting or aggrega-

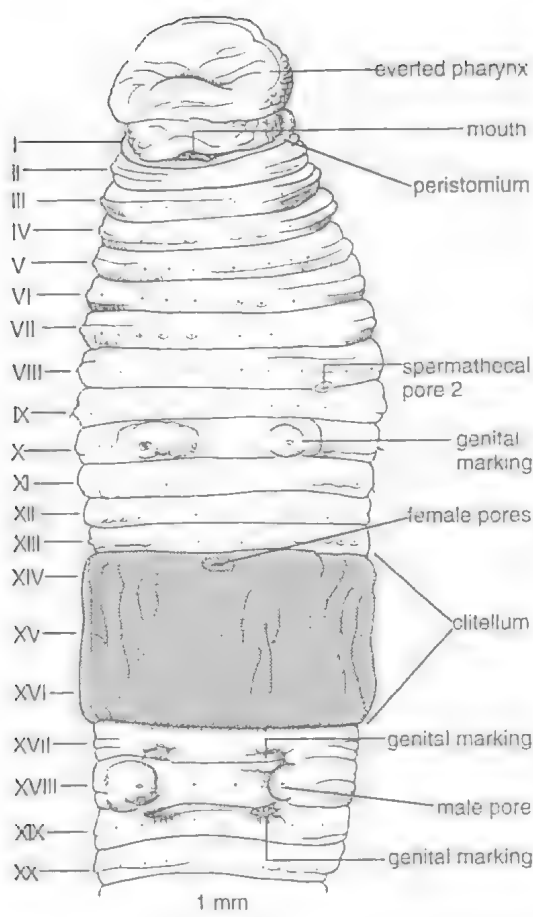


FIG. 18. *Propheretima hugalli* sp. nov., Holotype, QMG211452. Ventral view of forebody and clitellar region.

tion anteriorly; caudally tending to form lateral aggregations and with occasional intrasegmental funnels observed; presence or absence of median preseptal funnel not demonstrable; no enteronephry observed but absence requires confirmation. Free sperm masses and very large, convoluted iridescent funnels in X and XI; seminal vesicles racemose, in IX and XII. Prostates restricted to XVIII; each a tongue-like lobe with a minutely papillate surface indicative of racemose structure; the short narrow medianly directed duct joined entally by the conjoined vasa deferentia. Ovaries a pair in XIII, each a relatively large folded lamina with many chains of large oocytes with multiple stalks to the anterior sep-

tum; a pair of funnels on the posterior septum with ducts entering the body wall independently but close together. Spermathecae 2 pairs in VIII and IX, discharging at the anterior intersegments; each with a narrow bulbous ampulla, and a similarly shaped smaller diverticulum which is about two thirds the length of the spermatheca.

ETYMOLOGY

For Andrew Hugall, the collector.

REMARKS

Propheretima hugalli differs from the other species of the genus in having an intersegmental puckered pit anterior to and behind each male porophore and a pair of transverse pads equatorially in X with a small presetal, pore-like depression.

Spenceriella conondalei sp. nov. (Figs 20, 21)

MATERIAL EXAMINED

HOLOTYPE: QMG211422 (ex QMG1158).

PARATYPES: QMG211423-33, 10 clitellate specimens, all from 26°45'S, 152°37'E, Conondale Range, Qld., in leaf litter. Collected R. Raven, 13-18 May 1976.

DESCRIPTION

Length 26-40mm, mean 33mm. Width 2.2mm. Segments 81-109, mean 92 ($n=4$). Pigmentless buff in ethanol. Prostomium epilobous 1/2. First dorsal pore 5/6. Setae 18 in III; 30 in XII; 32 in XX; about 26 in caudal segments (H); $aa:ab:bc$:

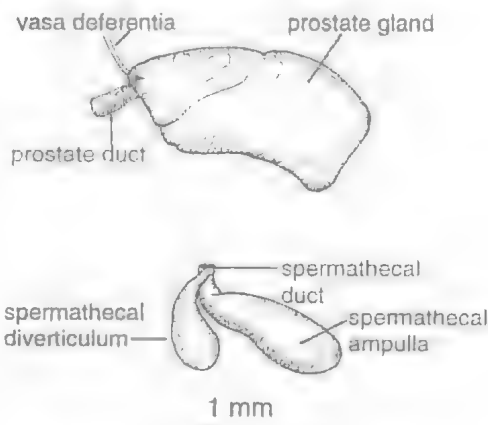


FIG. 19. *Propheretima hugalli* sp. nov., Holotype, QMG211452. A, right prostate. B, right posterior spermatheca.

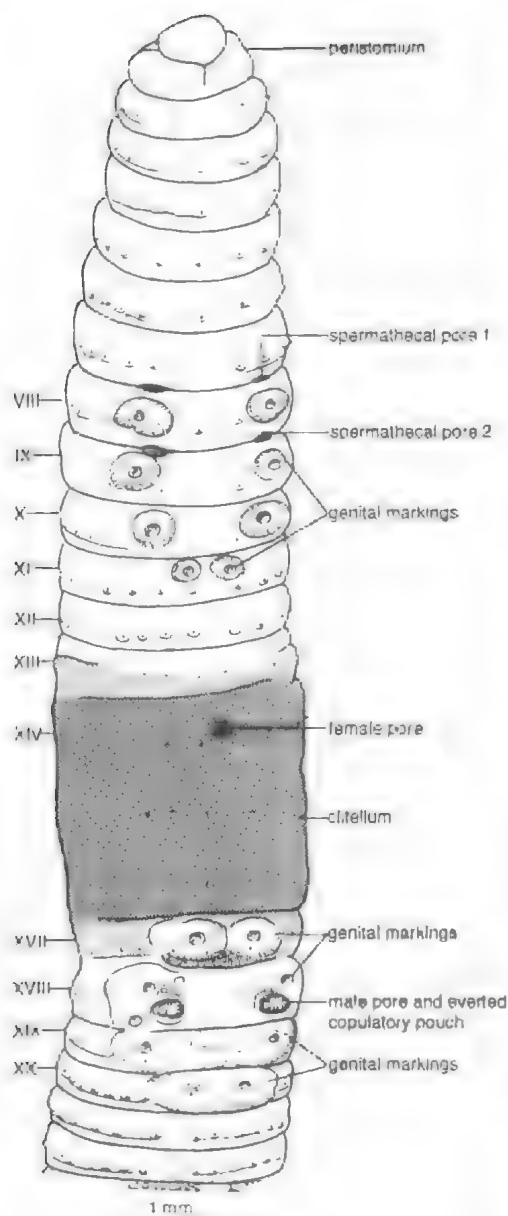


FIG. 20. *Spenceriella conndalei* sp. nov., Holotype, QMG211422. Ventral view of forebody and clitellar region.

cd:yz:zz = 1.6:1.0:0.5:0.5:0.5:1.0; dorsal and ventral breaks not apparent; possible vestiges of two setae, represented only by pore-like dimples, between the male pores; setae *a* sometimes absent in the vicinity of the genital markings, in segments VIII-X. Clitellum annular, best developed

on XIV-XVI but some development without tumescence in 1/2XIII, 1/2XIII and XVII. Male pores large orifices centred in *b* lines of XVIII, each occupied by a strongly protuberant, whitish everted copulatory pouch. Genital markings paired, each consisting of a low whitish subcircular to elliptical mound, with presetal pore-like centre; in VIII with the centre in *bc*; in IX immediately median of *c*; in X in or very slightly lateral of *b*; in XI in the immediate vicinity of *a* line; in XVII, in *ab* and in contact with its partner medianly; in XIX, in or immediately lateral of *b*; in XX, in or immediately lateral of *a*; the markings on XIX and XX, but not their pore-like regions, fused across the midline in each segment to form a single midventral pad; on XVIII a tumid area, extends laterally to about setae 5, and bears a pair of small pore-like markings anterolateral and another posterolateral to the male pores, lateral of *c*, sometimes with an additional pore anteromedian to the male pore. Some markings, particularly in VIII and/or XVIII, may be absent or unilateral in clitellate specimens. Female pore single, midventral, shortly anterior to the setal arc in XIV surrounded by a small elliptical field. Spermathecal pores transverse slits with thin white elliptical lips, in 7/8 and 8/9, their median borders in or immediately lateral of *b* lines

Dorsal blood vessel single. Last hearts in XIII. Gizzard moderately large, cylindrical and firmly muscular, in V but deflecting septum 5/6 posteriorly so as to end posteriorly in VIII relative to external segmentation. Calciferous glands absent but oesophagus vascularized and with an encircling blood vessel on each side in each of segments VIII-XIII. Intestine commencing in XV; with a low lobulated and not uniformly continuous dorsal ridge but no definite typhlosole; caeca absent; intestinal contents include quartz grains and pieces of wood. Several large meronephridial tufts anterior to the spermathecae, some with ducts to the pharynx, others exonephric. Several apparently astomate meronephridia on each side in anterior intestinal segments. Caudally with a median preseptal funnel and apparently some intrasegmental funnels though the latter were not demonstrable in some specimens. Testes and large iridescent funnels free in X and XI. Large racemose seminal vesicles in IX and XII. Ovaries conspicuous bunches of oocytes in XIII. Prostates racemose, flattened, subrectangular with a small accessory lobe behind the junction with the curved muscular duct. Spermathecae 2 pairs, in VIII and IX, each with a subspheroidal ampulla

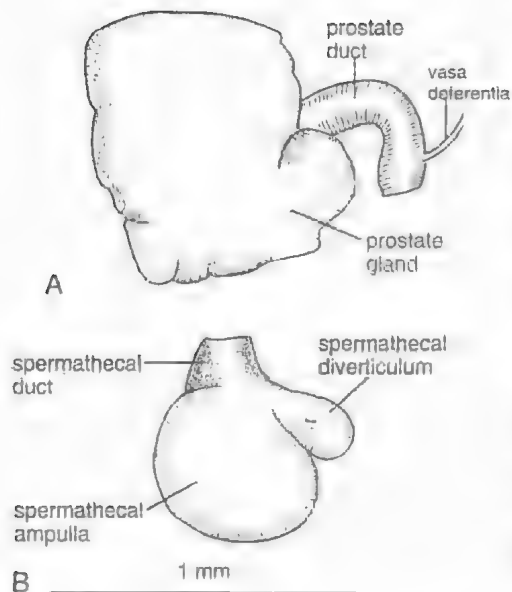


FIG. 21. *Spenceriella conondalei* sp. nov., Holotype, QMG21 1422. A, left prostate. B, right posterior spermatheca.

and a small, iridescent and therefore inseminated, clavate diverticulum.

ETYMOLOGY

For the type locality.

REMARKS

S. conondalei is exceptional in *Spenceriella* in having a single, not paired, female pore. The presence of questionable vestiges, as minute pits, of two setae between the male pores is therefore noteworthy in view of diagnosis of *Propheretima* and *Pheretima* sensu lato by the presence of well developed setae between the male pores. *S. conondalei* is excluded from both of these genera because of the absence of recognizable setae at these loci and because of its general similarity to *Spenceriella*. The well developed gizzard places it in the subgenus *Spenceriella* although the absence of calciferous glands is not typical of that subgenus.

DISCUSSION

The present study has added to the endemic earthworm fauna of Australia (Megascolecidae), one species of Acanthodrilinae (*Rhododrilus glandifera*) and nine species of Megascolecinae,

in the tribes Perionychini (*Heteroporodrilus montiserratae*, *Terrisswalkerius windsori*, *Cryptodrilus bunyaensis*); Dichogastrini (*Digaster lingi*, *D. moretonensis*); and Megascolecini (*Oreoscolex retrocystis*, *Propheretima eungella* gen et sp. nov., *Propheretima hugalli*, and *Spenceriella conondalei*). *Rhododrilus glandifera* is the second species of this primarily New Zealand genus to be described from Australia. It is possible that it has acquired the microscolecin arrangement of male pores (prostates one pair discharging with the vasa deferentia in XVII) from a precursor with the acanthodrilin arrangement (prostate pores 2 pairs, in XVII and XIX; male pores in XVIII) independently of the New Zealand species. If this were so, retention in *Rhododrilus* could not be supported and separate, new generic status would be required.

The type localities of *Heteroporodrilus montiserratae*, *Terrisswalkerius windsori*, *Digaster lingi*, *D. moretonensis*, *Oreoscolex retrocystis* and *Spenceriella conondalei* are well within the ranges of their respective genera. However, the insular locality of *D. moretonensis*, on Moreton Island, is of zoogeographic interest and *Cryptodrilus bunyaensis* represents a northern extension for its genus. The new genus *Propheretima*, has been erected for species which resemble the Oriental and Australo-Papuan *Pheretima* sensu lato assemblage of genera in having setae between the male pores but which are plesiomorphic in retaining the gizzard in segment V, not in the apomorphic location of VIII seen in all pheretimas. It endorses the author's view (Jamieson, 1977) that the ancestry of the *Pheretima* assemblage may have lain in Australia.

ACKNOWLEDGEMENTS

The author is grateful to those who collected or aided in collection of material described in this paper: E. Bradbury, M. Cunningham, G. Dyne, A. Hugall, J. Ledger, D. Ledger, E. Ling, K McDonald, A. Postle, and R. Raven. This study was made possible by ABRS and ARC grants to the author. All illustrations are by the author.

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A GROUND-TRAPPING SURVEY FOR SMALL MAMMALS IN CONTINUOUS FOREST AND TWO ISOLATED TROPICAL RAINFOREST RESERVES

SUSAN G. W. LAURANCE & WILLIAM F. LAURANCE

Laurance, S. G. W. & Laurance, W. F. 1995 12 01: A ground-trapping survey for small mammals in continuous forest and two isolated tropical rainforest reserves. *Memoirs of the Queensland Museum* 38(2): 597-602. Brisbane, ISSN 0079-8835.

We used mark-recapture methods to compare small mammal assemblages between continuous rainforest and two small (c. 500 ha), isolated rainforest reserves in north Queensland, Lake Eacham and Lake Barrine National Parks. Both parks had abundant populations of native rodents. *Uromys caudimaculatus* and *Melomys cervinipes* were significantly more abundant in the parks than continuous forest, while *Rattus fuscipes* was significantly less abundant in the parks. A few non-rainforest rodents (*Mus musculus* and *R. lutreolus*) and the edge-favouring *Antechinus flavipes* were captured in the remnants, but not in continuous forest. *Hypsiprinnodon moschatus* was present in both parks and continuous forest, while several other rare, forest-dependent mammals (e.g. *Antechinus godmani*, *A. stuartii*, *Dasyurus maculatus*) were not detected. Several of these trends have been observed in other rainforest remnants in the region, suggesting small mammal assemblages in these isolated parks have been influenced by forest fragmentation. □ rainforest mammals, trapping, forest fragmentation.

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Forest fragmentation can cause a wide range of ecological effects, including biotic and microclimatic changes associated with abrupt forest edges (Andren & Angelstam, 1988; Kapos, 1989; Williams-Linera, 1990; Laurance, 1991b), the decline or loss of specialised, forest-dependent fauna (Lovejoy et al., 1986; Laurance, 1991a), and dramatic changes in abundances of some species (Terborgh, 1992). Genetic changes, such as a progressive erosion of allelic diversity and heterozygosity, also may affect fragmented populations (Leung et al., 1993).

Large-scale clearing and fragmentation of tropical rainforest on the Atherton and Evelyn Tablelands in north Queensland began in the early 1900's and proceeded rapidly for the next several decades. By 1980, over 76,000ha of forest had been removed (Winter et al., 1987), leaving only scattered forest fragments on flatter areas of the Tablelands, ranging from about 1 to 600ha in area (Laurance, 1991a).

Two of the largest forest remnants on the Tablelands are Lake Eacham and Lake Barrine National Parks. The parks were initially designated as Scenic Reserves in 1888, then gazetted as National Parks in 1934 (Matthews, 1993). Each park is about 500ha in area with relic volcanic lakes occupying 103ha at Barrine and 52ha at Eacham. An Eacham Parish map published in 1931 identifies property subdivisions completely

surrounding both parks, suggesting they have been isolated from primary forest for at least 64 years.

The mammal faunas of the two parks have received only limited attention. Non-systematic trapping was conducted in both parks in the 1930's and the 1970's, mainly for mammal taxonomic studies (Taylor & Horner, 1973). J. W. Winter (pers. comm.) conducted spotlighting and trapping surveys at Lake Eacham in the mid-1970's, but Lake Barrine has not been surveyed systematically, nor have the mammal faunas in the parks been contrasted with those in nearby continuous forest.

The aim of this study was to contrast small mammal assemblages at Lakes Eacham and Barrine National Parks with those found in nearby continuous rainforest. These findings are relevant to the development of park management strategies, such as the creation of faunal corridors, which are currently being implemented to help ameliorate the effects of forest fragmentation.

METHODS

Lakes Eacham and Barrine (740-800m elevation) are located near the NE margin of the Atherton Tableland. The parks are separated from Gadgarra State Forest (680-900m elevation) by a clearing 1.5-2.5km in width comprised by cattle pastures and second-growth forest (Fig. 1). At

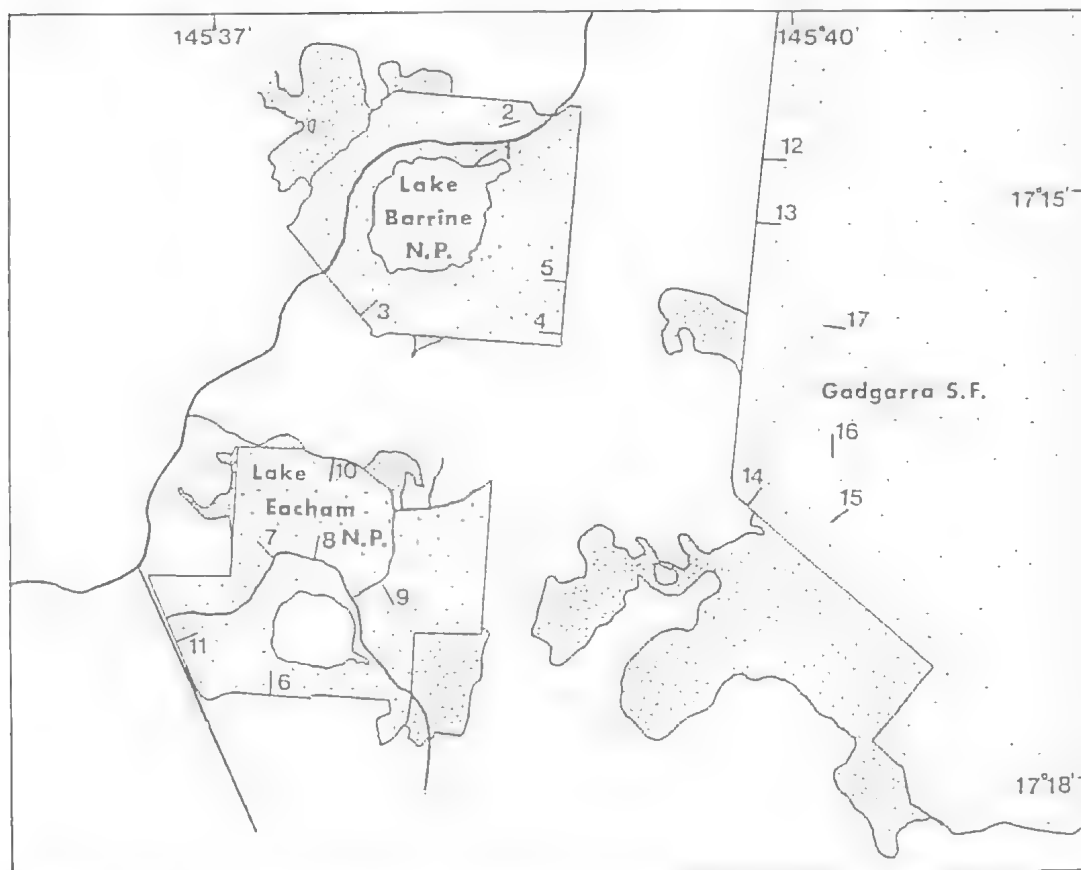


FIG. 1. Map of study area on the Atherton Tableland in north Queensland, showing locations of 17 trapping transects. Lightly stippled areas are rainforest, darkly stippled areas are second-growth forest, and unstippled areas are mostly cattle pastures.

Gadgarra, upland (>600m elevation) forests occur in a relatively narrow (4-6km-wide) band but are contiguous with the extensive Atherton Uplands (100,000ha). Much of Gadgarra was selectively logged in the 1950's and 1960's (Queensland Forest Service records). Forests at all three sites are mostly complex mesophyll vine-forest on basaltic soils, with patches of simple notophyll vine-forest on poorer metamorphic soils (Tracey, 1982).

Eacham and Barrine were censused in late July and early August 1994, while Gadgarra was censused in early October. Traps were positioned along a series of 210m-long transects. Each transect had 8 cage traps (30 x 30 x 60cm) and 14 Elliot box-traps (10 x 11 x 30cm) spaced in a regular sequence at 10 m intervals. Elliotts traps were baited with a mixture of rolled oats and vanilla essence, while cages were baited alternatively with the oats-vanilla mixture or dog food

(Chicken Chupp). Traps were operated for 4 consecutive nights.

Eacham and Gadgarra were each sampled with 6 transects (528 trap-nights each), while Barrine had 5 transects (440 trap-nights). At each site, 2-3 transects were used to sample forest interiors, while the remaining transects began at the forest edge and proceeded toward the interior (Fig. 1). Captured mammals were ear-tagged, weighed and examined to assess sex and reproductive condition, then released.

RESULTS

ABUNDANT RODENTS

We recorded 603 mammal captures (400 individuals) during the study. Four native rodents, the fawn-footed melomys *Melomys cervinipes*, Cape York rat *Rattus leucopus*, bush rat *R. fuscipes*, and white-tailed rat *Uromys caudimaculatus*,

were numerically dominant, comprising 94–98% of individuals captured at each site. The relative proportions of the four species did not differ significantly between the two forest fragments ($\chi^2=6.63$, $p>0.05$), while proportions in each fragment differed strongly from those in continuous forest (Eacham vs Gadgarra: $\chi^2=44.41$, $p<0.001$; Barrine vs Gadgarra: $\chi^2=37.18$, $p<0.001$; Chi-square tests for independence, $df=3$ in all cases). Because rodent communities in the two fragments appeared similar in composition, we pooled data from the fragment sites for the subsequent analysis.

We compared the mean abundance of each species in the two fragments to those in continuous forest (Fig. 2). *Melomys* ($p=0.019$) and *Uromys* ($p=0.012$) were both significantly more abundant in the fragments, while *Rattus fuscipes* was significantly less abundant ($p=0.001$). *Rattus leucopus* was quite abundant at Barrine but was patchily distributed and did not differ significantly between fragmented and continuous forest ($p=0.684$). Total rodent abundance (i.e. the combined abundances of the four common species) did not differ significantly between fragmented and continuous forest ($p=0.546$; all Mann-Whitney U-tests), although rodent populations in the fragments exceeded those in continuous forest by an average of 14–16%.

RARE MAMMALS

Five species were captured too infrequently to permit statistical analysis (1–6 individuals). Two yellow-footed antechinuses *Antechinus flavipes*, a swamp rat *Rattus lutreolus*, and a house mouse *Mus musculus* were captured at Barrine. Musky rat-kangaroos *Hypsiprymnodon moschatus* were captured at Eacham (1 animal) and Gadgarra (2 animals), and were occasionally observed during the day at all three sites. Finally, two long-nosed bandicoots *Perameles nasuta* were captured at each of the three sites.

DISCUSSION

Our short-term survey was unlikely to provide a complete census of small mammals in the study area.

Repeated sampling during the major seasons of the year, and the use of ground- and arboreal-traps with both meat and herbivore baits, are needed to provide a comprehensive sample of rainforest small mammal communities (Laurance, 1992). There also was a two-month interval between censuses of the parks and the controls.

Results, therefore, should be interpreted with some caution.

ABUNDANT RODENTS

Despite limited sampling our findings appear similar in several respects to those observed in larger (20ha) forest fragments on the southern Atherton Tableland (Laurance, 1994b), suggesting the small mammal faunas at Lakes Eacham and Barrine exhibit some effects of forest fragmentation.

On average, assemblages of abundant native rodents were 14–16% more abundant in Eacham and Barrine than in nearby unfragmented forest, although this difference was not significant. On the southern Atherton Tableland (30–40km south of Eacham and Barrine), the same rodent species were on average 20–27% more abundant in fragments than continuous forest (Laurance, 1994b). These increases may result from ecological changes in fragmented rainforest, such as dense ground and understorey cover associated with forest edges and disturbed forest, that are favoured by some rodents. A recent comparison of forest structural variables at Eacham and Barrine with nearby continuous forest, suggested the parks exhibit relatively heavy disturbance, which may result from increased wind damage near forest edges compounded by the relatively high topographical position of the parks (Laurance, 1994a). Native rodents may also increase in fragments because of novel foraging opportunities in surrounding pastures or secondary habitats, or because larger, forest-dependent predators decline in most fragments (Laurance, 1990; 1994b).

The fawn-footed melomys *Melomys cervinipes* was significantly more abundant at Eacham and Barrine than in unfragmented forest. On the southern Tableland, this species also was more abundant in both small (1.4–12.7ha) and large (21–590ha) fragments than in unfragmented forest. *Melomys* appears to favour recent treefall gaps and other disturbed forest, which probably accounts for its success in remnants (Laurance, 1994b).

The bush rat *Rattus fuscipes* was much less abundant in the parks than continuous forest, while the Cape York rat *R. leucopus* was unusually abundant at Barrine but less abundant at Eacham and the controls. Cape York rats increased on the southern Tableland in many smaller (<20ha) forest remnants while bush rats generally declined. Like the fawn-footed melomys, the Cape York rat appears to favour forest edges and areas with many treefalls and

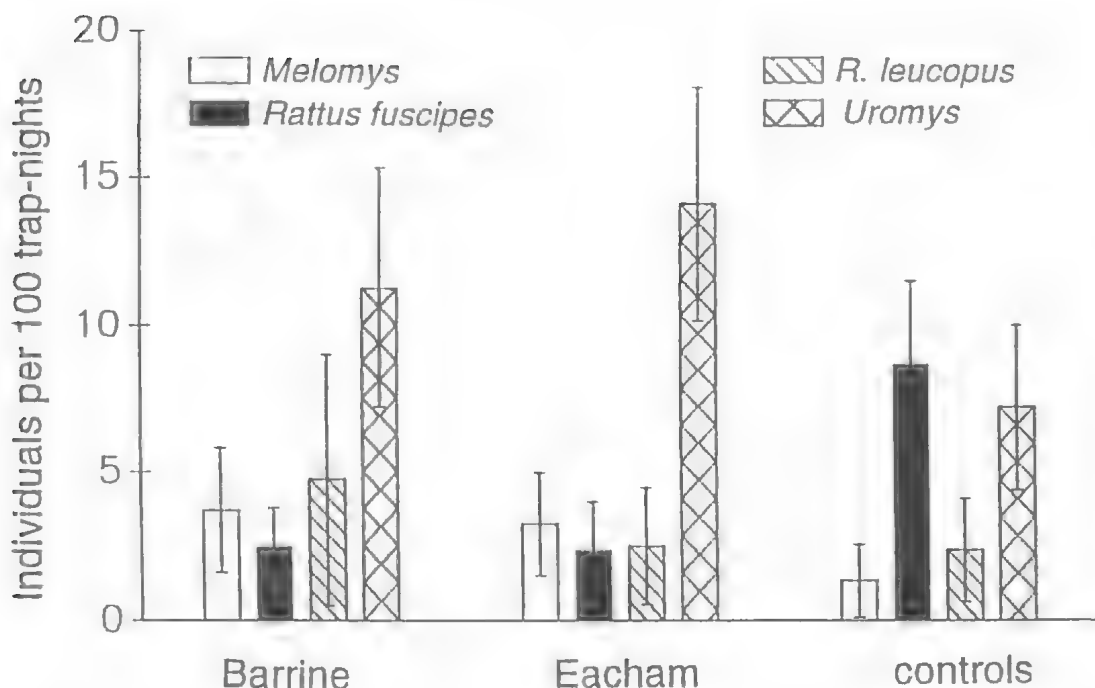


FIG. 2. Standardised abundance estimates (mean + σ) of four abundant rodent species from trapping transects in Lake Eacham and Lake Barrine National Parks, and in nearby continuous forest (Gadgarra State Forest).

dense rattan growth, while the bush rat generally avoids areas with high densities of Cape York rats (Laurance, 1994b).

The white-tailed rat *Uromys caudimaculatus*, a large (500-900g), aggressive omnivore, was unusually abundant in both parks. In a trapping survey in the 1970's, J. W. Winter (pers. comm.) also found the white-tailed rat to be the most frequently-captured small mammal at Lake Eacham. These results differ from observations on the southern Tableland, where white-tailed rat abundance did not differ significantly between larger (>20ha) fragments and continuous forest (Laurance, 1994b). Elevated abundances of white-tailed rats in fragments could result in intensified predation on large rainforest seeds (Osunkoya, 1993), nesting birds and small vertebrates (Laurance et al., 1993; Laurance & Grant, 1994). In future studies, it would be useful to contrast the intensity of predation in the parks with that in continuous forest, using seeds or experimental bird nests (c.g. Laurance et al., 1993; Harrington et al., in press).

RARE MAMMALS

Two non-rainforest rodents were captured at Lake Barrine, the house mouse *Mus musculus*, commonly associated with human habitations, and the swamp rat *Rattus lutreolus*, which usually favours open, grassy habitats. J. W. Winter (pers. comm.) captured *Mus musculus* and *Rattus rattus* at Lake Eacham in the 1970's, although we did not encounter these species at Eacham in 1994. Non-rainforest rodents also were encountered, albeit infrequently, in many forest fragments on the southern Atherton Tableland (Laurance, 1994b). Thus, forest fragments appear increasingly prone to invasions by non-native rodents although native rodents, which are abundant and highly territorial, probably prevent large-scale invasions of non-forest species.

Interestingly, Lake Barrine is the type locality for *Rattus lutreolus lacus*, a disjunct north Queensland subspecies initially encountered in 1937 (Taylor & Horner, 1973). In the 1970's J. W. Winter (pers. comm.) attempted to confirm the presence of *R. l. lacus* in the parks and intervening paddocks, but did not encounter it. Our study confirms the presence of swamp rats in the

area. The single animal we encountered was captured inside Lake Barrine Park, 160m from the nearest forest edge.

The frequency of trapping of *Antechinus* varies considerably during the year, peaking from about March to June (Laurance, 1992), and the present study would have been unlikely to sample these species adequately. We captured only two yellow-footed antechinuses *Antechinus flavipes* at Barrine, and none at Eacham or in continuous forest. On the southern Tableland, *A. flavipes* strongly favoured forest fragments over continuous forest and usually was captured within 30 m of forest edges (Laurance 1994b). The Atherton (*A. godmani*; Laurance, 1993) and brown antechinuses (*A. stuartii adustus*), both of which are strongly rainforest-dependent (Laurance, 1994b), also could potentially occur at Eacham and Barrine. Ideally, both remnants should be thoroughly sampled during the optimal trapping period for antechinuses.

The rare spotted-tailed quoll *Dasyurus maculatus* was not detected during the study and is unlikely to persist in the parks. However, both parks currently maintain good populations of the musky rat-kangaroo *Hypsiprymnodon moschatus*, a rainforest endemic. This species appears to have disappeared from even the largest (up to 590ha) fragments on the southern Atherton Tableland (Laurance, 1994b), although it was detected in a few small fragments on the north-central Tableland that nearly abutted continuous forest (Grey, 1994). The musky rat-kangaroo is strongly rainforest-dependent, thus populations in the two parks may be genetically and demographically isolated from other such populations.

A recent initiative by the Queensland Department of Environment and Heritage to establish an 80m-wide faunal corridor between Lake Barrine and Gadgarra State Forest, may facilitate dispersal of musky rat-kangaroos and other forest-dependent species, reducing the isolation of faunal populations at Barrine. The effectiveness of such corridors has not yet been rigorously assessed (cf. Noss, 1987; Simberloff & Cox, 1987; Bennett, 1990), however, and future research is clearly needed to test the efficacy and design of faunal corridors, especially in the tropics.

ACKNOWLEDGEMENTS

We thank John Winter, Les Moore, Luke Leung and Peter Green for commenting on earlier drafts of the manuscript. Eleanor Collins, Arthur

Sellers and others from the Lake Eacham National Park Volunteers Group assisted with field work. This project was partially supported by a senior research fellowship awarded to WFL by the Wet Tropics Management Authority.

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**PALORCHESTES SELESTIAE, A NEW SPECIES OF PALORCHESTID MARSUPIAL
FROM THE EARLY PLIOCENE BLUFF DOWNS LOCAL FAUNA, NORTHEASTERN
QUEENSLAND**

BRIAN MACKNESS

Mackness, B.S. 1995 12 01. *Palorchestes selestiae*, a new species of palorchestid marsupial from the early Pliocene Bluff Downs Local Fauna, northeastern Queensland. *Memoirs of the Queensland Museum* 38(2): 603-609. ISSN 0079-8835

Palorchestes selestiae sp. nov. from the early Pliocene Bluff Downs Local Fauna is described on the basis of an isolated LM¹. It is larger than *P. painei* and *P. parvus* but smaller than *P. azael* in both length and width of lophs. It is also differentiable from all other palorchestids on the basis of the combination of links between, or stemming from lophs. It is the second undoubted Pliocene species and shares features of both *P. parvus* and the Pleistocene *P. azael*. With its relatively derived anterior morphology and plesiomorphic posterior morphology, *P. selestiae* challenges current notions about the phylogenetic relationships of diprotodontid marsupials which suggest that small size and simple structure are probably plesiomorphic features. □ *Palorchestes*, *palorchestids*, *Bluff Downs Local Fauna*, *Pliocene*, *Diprotodontia*, *Marsupialia*.

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Palorchestes was described by Owen (1873) on the basis of an anterior portion of a cranium including the rostrum. The holotype was obtained by Dr Ludwig Becker and described by Owen (1874) as *P. azael* from an unspecified deposit in Victoria interpreted by Mahoney & Ride (1975) as the River Tambo in Gippsland. Owen (1873:387) considered *Palorchestes* to be "... the largest form of kangaroo hitherto found".

Owen regarded *Palorchestes* to be a macropodid, a view followed by Simpson (1945) who placed the genus within the subfamily Macropodinae. Raven & Gregory (1946), however, placed it in the subfamily Sthenurinae while Tate (1948) placed it in a new subfamily of kangaroos, the Palorchestinae. Woods (1958) was the first to recognise the diprotodontid rather than macropodid affinities of *Palorchestes*. Archer & Bartholomai (1978) followed this assignment but elevated Tate's Palorchestinae to family level.

Palorchestes selestiae sp. nov. is described here on the basis of an isolated LM¹ from the fluvial and lacustrine deposits of the Allingham Formation, northwest of Charters Towers, northeastern Queensland. This formation contains a diverse assemblage known as the Bluff Downs Local Fauna, and has been the subject of many studies, most recently including those of Vickers-Rich (1991), Mackness et al. (1993), Boles & Mackness (1994) and Mackness (in press). Archer & Wade (1976) assigned an early Pliocene age to the assemblage on the basis of the interpreted age of the overlying Allensleigh Ba-

salt. Archer, in Archer & Wade (1976) noted, but did not name three other diprotodontoids from the Bluff Downs Local Fauna, a species of *Euryzygoma*, a species of *Zygomaturus* and an unidentified 'notothere'.

TERMINOLOGY

Dental homology of cheekteeth follows Lockett (1993) such that the first adult molariform tooth is M¹ and the deciduous molariform tooth is dP³. Terminology of crown morphology (Fig. 1) follows that used by Archer (1976) except that the metaconule is used instead of hypocone following Tedford & Woodburne (1987). The gotic terminology used follows Every (1972). Abbreviations for specimen numbers: QMF, Queensland Museum fossil collection; UCMP, University of California, Berkeley; P, South Australian Museum.

SYSTEMATICS

Order DIPROTODONTIA Owen, 1866

Suborder VOMBATIFORMES

Woodburne, 1984

Infraorder VOMBATOMORPHIA

Aplin & Archer, 1987

Family PALORCHESTIDAE (Tate, 1948)

Archer & Bartholomai (1978)

Palorchestes Owen, 1873

TYPE SPECIES

Palorchestes azael Owen 1873.

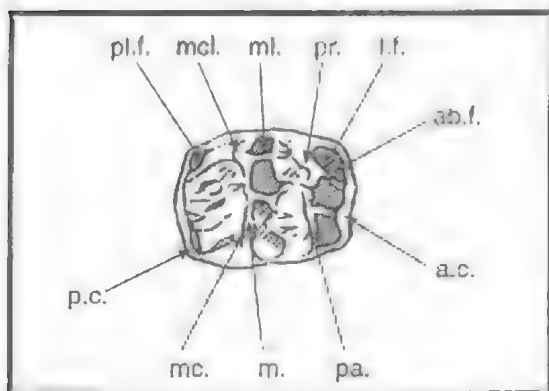


FIG. 1. Diagram showing terminology of an M^1 of *P. selestiae*. Regions used for measurements in Table 1 are also presented using the holotype (QMF12455). Arrow indicates anterior of molar. Abbreviations: ab.f. anterobuccal fossa; a.c. anterior cingulum; l.f. lingual forelink; m. metaloph; mc. metacone; mcl. metaconule; ml. midlink; pa. paracone; p.c. posterior cingulum; pl.f. posterolingual fossa; pr. protocone.

***Palorchestes selestiae* n. sp.**
(Fig. 2)

MATERIAL EXAMINED

HOLOTYPE: QMF12455, an isolated LM^1 , Main Quarry (19° 43' S, 145° 36' E), Allingham Formation, Bluff Downs Station, northeastern Queensland.

ETYMOLOGY

For Selesti Smith of Bluff Downs Station.

DIAGNOSIS

Small LM^1 with lingual forelink terminated in the cingular valley and not in contact with the cingulum; second incipient buttress on the back of the metaloph; posterolingual fossa well developed; posterior cingulum rises to an apex mid-length; incipient buttressing on the posterior wall of metaloph; one midlink and two incipient midlinks; double forelinks.

DESCRIPTION

The holotype consists of a complete, relatively unworn LM^1 , lacking any remnant of the roots. The metaconule is the tallest cusp with the protocone, paracone and metacone subequal in height. Protocone linked to the paracone by a well-defined sinuous protoloph. Metaconule linked to the metacone by a well-defined crescentic metaloph whose ends are posteriorly deflected.

The anterior cingulum fails to extend around the base of the protocone. A slight anterobuccal cingulum is continuous with the anterior cingulum. Otherwise there are no lingual or buccal cingula. Anterior cingulum high resulting in deep fossae where the forelinks join the cingulum. Posterior cingulum closer to the metaloph than the anterior cingulum is to the protoloph. As a result, the posterior cingular valleys are not as deep as the anterior ones. There is a conspicuous interproximal wear facet on the anterobuccal corner of the tooth, presumably caused by abrasion against P^3 .

There are a number of blades on the crown. Where the enamel has been breached, both sets of leading and trailing blades (*sensu* Every, 1972) can be seen on the protoloph and metaloph. A number of secondary blades are also present. One blade (the apical margin of the lingual forelink) leads from the protocone to the anterior cingulum. Another blade (the apical margin of the buccal forelink) connects the protoloph, approximately one third of the way between the paracone and the protocone, to the anterior cingulum. A well-developed primary midlink joins the protoloph to the metaloph. The posterior end of this midlink contacts the trailing edge of the

TABLE 1. Comparative measurements of *Palorchestes* M^1 in mm.

Specimen	No.	L	AW	PW
<i>P. selestiae</i>	Holotype	22.6	16.6	16.9
<i>P. parvus</i>	QMF784(cast)	20.7	15.7	15.4
	QMF12476		15.4	15.3
	QMF2963	19.3	14.9	14.4
	QMF3719(cast)	19.3	15.0	14.2
	QMF2967	19.4	15.6	15.6
	QMF2965	20.9		14.5
	QMF789	19.5		
<i>P. cf parvus</i>	P24097 (R)	18.8	13.6	12.9
	P24097 (L)	18.6	13.9	13.6
<i>P. azael</i>	QMF772 (cast)	26.6	21.9	21.5
	QMF3837	25.8	20.7	19.7
	P31370	28.3	21.8	21.4
	P31371	28.3	22.6	21.9
	P31372	26.1	22.9	21.9
<i>P. painei</i>	UCMP70553(R)	16.5*	13.6*	13.8
	UCMP70553(L)	16.8	14.4	13.7
	UCMP70550(R)	16.7	13.9*	13.7
	UCMP66521(L)	17.8	14.0*	13.2*

* = approximation

TABLE 2: Summary of links in *Palorchestes* M¹
() Incipient link; - Link/s worn, * cast.

Specimen	No.	Forelinks	Midlink	Hindlinks
<i>P. selestiae</i> sp. nov.	Holotype	2	1(1)	(2)
<i>P. parvus</i>	QMF784*	2(1)	2	2
	QMF12476	2	2	
	QMF2963	2(1)	2	2
	QMF3719*	2	2	2
	QMF2967	2	2	2
	QMF2965	2	2	
<i>P. azael</i>	QMF772*	2	1(2)	0
	QMF3837	2	1	0
<i>P. painei</i>	UCMP70553	1	1	1
	UCMP65521	1	1	1

posterior metaloph blade. Another less developed midlink occurs on the lingual side of the tooth. This smaller link is steeply v-shaped rather than shallowly v-shaped as is the primary midlink. There is a very deep fossa between these two midlinks.

There is also a swollen buttress on the posterior flank of the protoloph, buccal to the primary midlink. Another steeply inclined buttress descends posteriorly to the posterior cingulum from the tip of the metaconule and supports an incipient blade that connects the apex of the metaconule to the posterior cingulum. A smaller blade-like structure is present on the posterior wall of the metaloph, buccal to the primary posterior blade. There is some slight crenulation of the enamel at the base of the lophs.

REMARKS

P. selestiae is approximately 3/4 the size of *P. azael* Owen and is 1/5 larger than *P. parvus* De Vis. Whilst closer in size to *P. parvus*, *P. selestiae* is morphologically closer to *P. azael*. *P. azael* differs in that the lingual forelink links the protocone to the anterior cingulum, and lacks the second incipient buttress on the back of the metaloph. *P. selestiae* has a better developed posterolingual fossa and the apex midlength on the cingulum is absent in *P. azael*. In *P. parvus* the anterobuccal fossa is less developed, both forelinks join the anterior cingulum, there are two well-defined hindlinks which join directly with the posterior cingulum, and two midlinks are present. *P. painei* Woodburne has a definite midlink, absent in *P. selestiae*, and it lacks the double forelink and the two incipient buttresses on the posterior wall of the metaloph.

PHYLOGENETIC AFFINITIES

The early Miocene *Nagapakaldia tedfordi* and *Pitikantia dailyi* (Stirton, 1967) from the Tirari Desert of South Australia have previously been regarded as the pleisomorphic sister group (subfamily Incertae) of the apparently more derived Palorchestinae based on synapomorphies in the auditory region and neurocranium (Stirton et al., 1967). It has been further suggested by Stirton et al. (1967:154) that *Pitikantia* "... is much nearer, if not in, an ancestral position to *Palorchestes*". Archer (1984), however, observed that there was little evidence to regard the two groups as monophyletic, with species of *Ngapakaldia* and *Pitikantia* lacking the specialized molars and retracted nasal bones of palorchestines, even though their basicranial morphology was similar. Murray (1986) described the middle Miocene *Propalorchestes novaculacephalus* from the Bullock Creek Local Fauna and, based on its cranial base, glenoid fossa morphology and auditory region, placed it within the subfamily Palorchestinae. Subsequently, Murray (1990) described the dentition of *P. novaculacephalus* as well as a new taxon, *P. ponticulus* from D-site (System A), Riversleigh, Queensland. The latter was also placed within the Palorchestinae.

The M¹, the most diagnostic tooth for palorchestids (Woods, 1958; Woodburne, 1967), is characterised by elaborated fore-, hind- and midlinks. These features are lacking in species of *Ngapakaldia* and *Pitikantia* but present or incipient in *Propalorchestes novaculacephalus*, considered to be the sister group of *Palorchestes* Murray (1986, 1990). *Palorchestes painei* has the simplest system of links with one fore-, one hind, and one midlink which is the condition also seen in *P. novaculacephalus*. All other species of *Palorchestes* have two forelinks as a synapomorphy.



FIG. 2. *Palorchestes selestiae* holotype QMF12455. Actual size. Occlusal view stereo pair. Anterior at top.

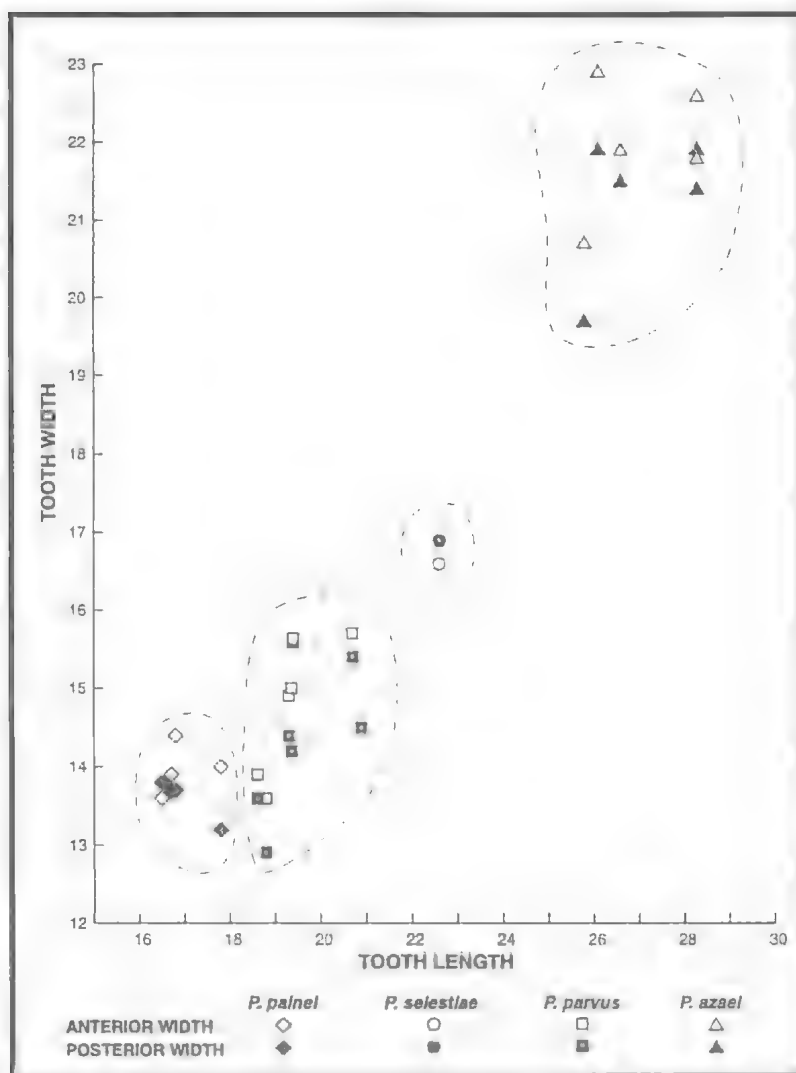


FIG. 3. Bivariate plots of tooth length against anterior width (") and tooth length against posterior width M^1 of *Palorchestes* species.

Palorchestes selestiae and *P. azael* share accessory midlinks and the reduction of hindlinks as synapomorphies while *P. parvus* has two hindlinks and two midlinks as autapomorphies. The development of accessory hindlinks and the lingual forelink not extending to the anterior cingulum in *P. selestiae* are considered autapomorphies for this taxon.

Palorchestes selestiae indicates need for caution in determining phylogenetic relationships within diprotodontoid lineages based on size alone. Stirton *et al.* (1967) suggested that molar size and complexity in diprotodontoids were in-

verse correlates of age. By those measures, *P. painei*, as the smallest species, ought to be the oldest followed, in decreasing age and increasing size by *P. parvus*, *P. selestiae* and *P. azael*. However, *P. selestiae* comes from a demonstrably early Pliocene site, whereas the smaller *P. parvus* comes from early to middle Pliocene sites which does not support the biostratigraphic argument of Stirton *et al.* (1967).

Several authors (Archer, 1976b; Murray, 1990) have proposed that the bilophodont upper molars of species of *Palorchestes* are derivable from subselenodont animals such as wynyardiids. Murray (1990:49) suggests "...The possibility of paraphyletic bilophodonty could not be ruled out, particularly with respect to the diprotodontids". In this view those animals such as the late Miocene *P. painei* which had the least development of selenodont features would be regarded as the most derived. It would then follow that, barring convergence, the more elaborate the cresting, the more plesiomorphic the animal. The selenodont groundplan is still evident in *P. selestiae*, even though it has been obscured to some degree by the development of lophs.

PALAEOECOLOGY

Palorchestids are uncommon elements in most Australian marsupial faunas although they have a long Tertiary and Quaternary history (Murray, 1991). The oldest known representatives are species of *Ngapakaldia* and *Pitikantidia* from the Oligo-Miocene deposits of central Australia and Riversleigh in northwestern Queensland. At the younger end of their time range, some may be

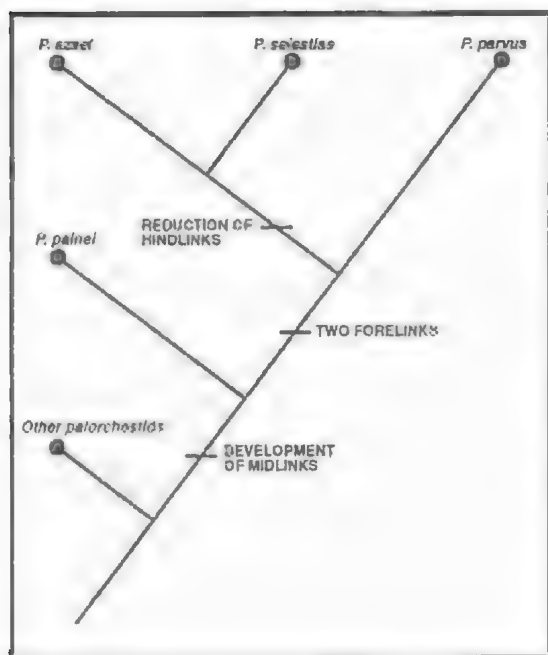


FIG. 4. Cladogram of taxa based on M^1 morphology.

only 30 000 yBP (Murray, 1991) and it has been suggested that *Palorchestes* was contemporaneous with humans. Murray & Chaloupka (1984) have interpreted an Aboriginal rock painting in the Arnhem Land escarpment as a possible rendition of a species of *Palorchestes* although this has been questioned (Lewis, 1986; Chaloupka & Murray, 1986; Mackness, 1992).

The reduction and retraction of the nasals, along with a conspicuous fossae for large *nasomaxillolabialis* muscles and a narrow, protracted rostrum have been used as a basis for reconstructing palorchestids with a trunk and the basis of their popular description as 'marsupial tapirs' (Bartholomai, 1978; Flannery, 1983; Flannery & Archer, 1985; Murray, 1991). The long, narrow deeply grooved symphysis suggests that palorchestids had long protrusible giraffe-like tongues (Murray, 1991). The spatulate lower incisors are almost parallel to strongly developed diastemal crests and interpreted by Murray (1991) as probably being used to strip leaves or crop clumped vegetation. Little has been published about the postcranials of palorchestids. Woods (1958) cast doubt on the association of postcranials with skull remains suggested by several authors (Owen, 1876; Gregory, 1902; Fletcher, 1945). Archer (1984), however, has noted that *Palorchestes* has powerful forelimbs

equipped with large laterally compressed claws. Flannery & Archer (1985) have used postcranial material and teeth to attempt a reconstruction of two species. Their analyses suggested the possibility that species of *Palorchestes* were medium-sized folivores that may have used their powerful claws and arms to rip bark off trees for food or to uproot shrubs with tuberous roots.

ACKNOWLEDGEMENTS

I thank Michael Archer and Suzanne Hand for helpful comments on the manuscript. Sue Creagh, Peter Murray, Neville Pledge and Ralph Molnar for access to other palorchestid specimens. Jack, Rhonda, Bram, Troy and Selesti Smith of Bluff Downs Station continue to provide tremendous support for this ongoing research. I thank Henk Godthelp, Darren Sprott and Frank Coffa for their assistance. Collection of the Bluff Downs material was supported in part by an ARC Program Grant to M. Archer; a grant from the Department of Arts, Sport, the Environment, Tourism and Territories to M. Archer, S. Hand and H. Godthelp; a grant from the National Estate Program Grants Scheme to M. Archer and A.

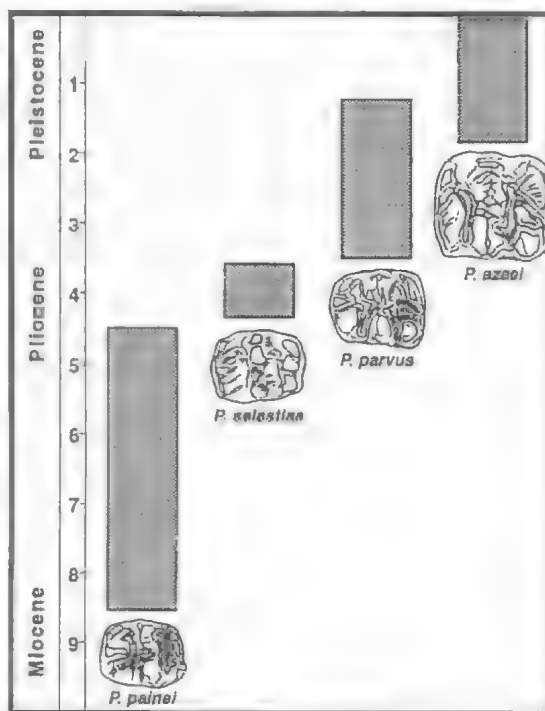


FIG. 5. Distribution of species of *Palorchestes*.

Bartholomai; and grants in aid to the Riversleigh Research Project from Wang Australia, ICI Australia and the Australian Geographic Society.

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GEHYRA DUBIA (MACLEAY, 1877) CONFIRMED AS SENIOR SYNONYM OF PEROCHIRUS MESTONI DE VIS, 1890. *Memoirs of the Queensland Museum* 38(2):610. 1995:- The gecko *Perochirus mestoni* De Vis, 1890 was described from a specimen collected from Bellenden Ker in north-east Queensland. Following examination of the holotype (Queensland Museum QMJ236), the name was placed in the synonymy of *Gehyra variegata* (Dumeril & Bibron, 1836) by Kluge (1963). This synonymy was followed by Covacevich (1971), Cogger et al. (1983) and Ingram (1990).

Recently, Bauer & Henle (1994) noted that the type locality and reported size of the holotype were more consistent with *Gehyra dubia* (Macleay, 1877) than *Gehyra variegata*, and tentatively synonymised *P. mestoni* with the former, though recommending that the holotype be re-examined.

The holotype of *P. mestoni* is faded, dessicated, contorted and damaged. The left mandible and associated tissues are missing, all toes and fingers other than the fourth toe on the right pes are missing, and the body is broken almost into two, probably by previous attempts at measurement of snout-vent length.

Nonetheless, diagnostic features (King, 1985) of *Gehyra dubia* are present on this specimen, a female with greatly distended endolymphatic sacs. The rostral scale is about 1.5 times wider than tall, gabled, and has at least three internasals bordering its dorsal margin. The right postmental contacts only the first infralabial, and is short, approximately twice as long as broad. The fourth toe on the right pes has nine expanded lamellae, the apicalmost divided, the remainder deeply creased. The snout-vent length is not able to be accurately measured, but is certainly greater than 50mm. Although Bauer & Henle (1994) interpret De Vis' (1890) statement "length 106mm" as snout-vent length, comparison of measurements of head and limb with the holotype indicates that this is a total length measurement.

The pattern, though faded, consists of at least broken fine dark vermiculations over the head and neck, consistent with photographs of live *G. dubia* (Wilson & Knowles, 1988).

The type locality lies outside the known distribution of *G. variegata*, but well within the known distribution of *G. dubia* (Ingram & Raven, 1991).

Consequently, *Perochirus mestoni* is formally synonymised with *Gehyra dubia*. This action requires no changes to current nomenclature.

Kluge's erroneous synonymy is understandable given the state of knowledge of Australian *Gehyra* systematics. At the time of his paper, *G. variegata* was differentiated from a composite *G. australis* largely on the basis of division of the distal subdigital lamellae. Additional characters distinguish-

ing *variegata* from the *G. australis* complex and recognition of additional species in the latter group awaited the work of Mitchell (1965) and King (1985).

Acknowledgements

I thank Patrick Couper and Jeanette Covacevich for assistance during my work at the Queensland Museum.

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STATUS OF THE LATE PLEISTOCENE FOSSIL DARTER *ANHINGA LATICEPS* (DE VIS, 1906)

BRIAN S. MACKNESS & GERRY F. VAN TETS

Mackness, B.S. & van Tets, G.F. 1995 12 01. Status of the late Pleistocene fossil darter *Anhinga laticeps* (De Vis, 1906). *Memoirs of the Queensland Museum* 38(2): 611-614. Brisbane. ISSN 0079-8835.

Plotus (= *Anhinga*) *laticeps* (De Vis, 1906), described from the late Pleistocene sediments of Coopers Creek, was compared with 31 specimens of the extant *Anhinga melanogaster novaehollandiae*. While *A. laticeps* has a large interorbital width and nasofrontal hinge relative to extant darters, these do not constitute sufficient differences to justify its separation as a species. *Anhinga laticeps* is, therefore, recognised as a junior synonym of *A. n. novaehollandiae*. □ *Anhinga laticeps*, darter, taxonomy, Pleistocene, Anhingidae Aves

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Charles W. De Vis described numerous fossil birds between 1885 and 1911 (van Tets & Rich, 1990). Some of these were based on a collection made by Professor Gregory of over 200 small bones from the deposits around Lake Eyre (De Vis, 1906). A fossil cranium and partial pelvis from Coopers Creek were described as a darter *Plotus* (= *Anhinga*) *laticeps* (De Vis, 1906). A museum label, in the handwriting of De Vis, also lists a coracoid (No. 70) on the same card as the two former specimens but this bone or bone fragment was not mentioned by De Vis in his original description nor has it been seen or noted by any subsequent author and so must, therefore, be presumed lost.

De Vis (1906:18), in his description of *P. laticeps*, stated that "... this cranium is in all its dimensions somewhat larger than that of *P. novaehollandiae*, it prohibits us referring it to the small species previously described *P. parvus*". *Plotus parvus* De Vis (1906) has since been shown to be a Little Pied Cormorant *Phalacrocorax melanoleucos* (Miller, 1966).

Miller (1966) reviewed the cranium and pelvic fragment described by De Vis and nominated the cranium as the lectotype of *Anhinga laticeps* (as De Vis did not formally specify a type) and referred the pelvic fragment to the extant *A. melanogaster novaehollandiae*. While Miller (1966) considered *A. laticeps* to be a valid species, Brodkorb & Mourer-Chauviré (1982) have since questioned this view. Miller (1966:318) also reviewed a number of Pleistocene darter fossils from central Australian deposits and concluded that "they differ in no aspects of size or shape", assigning all to the extant *A. n.*

novaehollandiae. Mackness (in press) has recently described a new fossil darter from the early Pliocene Bluff Downs Local Fauna, the only other extinct member from the Anhingidae recorded from Australia to date.

De Vis, 1906. *A. fossil cranium and partial pelvis*

Anhinga laticeps (De Vis, 1906) *A. laticeps* (= *Anhinga*) *laticeps* (De Vis, 1906)

De Vis type material was borrowed from the Queensland Museum. Fossil remains of other darters were in the Australian National Wildlife Collection, CSIRO Division of Wildlife and Ecology, on loan from other institutions. Comparisons were made with 31 specimens of the extant *A. n. novaehollandiae* as well as all fossil material referred to this taxon. Taxonomic position of the Old World darters follows Mayr & Cottrell (1979) and Marchant & Higgins (1990) in recognising only one species, *Anhinga melanogaster*. Terminology of bones is from van den Driesch (1976). Abbreviations for specimen numbers: AM, Australian Museum; ANWC, Australian National Wildlife Collection; CSIRO, Division of Wildlife and Ecology; MV, Museum of Victoria; QM, Queensland Museum; ROM, Royal Ontario Museum; SAM, South Australian Museum; UCMP, University of California Museum Paleontological Collection.

Anhinga melanogaster novaehollandiae. While Miller

MEASUREMENTS

Measurements following van den Driesch (1976) were made using vernier callipers accurate to 0.05mm and summarised below. Statistical analysis of these measurements is provided in Table 1. All fossil and modern specimens used for comparisons, were considered to represent

TABLE 1. Measurement (mm) of cranium. Measurements as defined below: range; mean \pm standard deviation; standard error, coefficient of variation (%); 95% confidence interval of the mean.

Measurement	<i>Anhinga m. novaehollandiae</i> n=31	<i>A. laticeps</i> n=1
CGL	45.6-50.8 47.4 \pm 1.24 .001, 2.6 47.3-47.4	49.6
CGW	20.8-24.7 22.8 \pm 0.78 0.14, 3.4 22.6-23.1	23.0
COW	5.9-7.7 6.7 \pm 0.41 0.07, 6.1 6.7-6.8	8.1
CDW	18.0-21.6 19.7 \pm 0.89 0.20, 4.5 19.3-20.1	19.5
CGW	16.1-19.1 17.6 \pm 0.75 0.13, 4.2 17.3-17.8	17.4
CIW	8.1-10.2 9.3 \pm 0.53 0.10, 5.6 9.1-9.5	20.3

fully grown or mature individuals, based on the absence of the juvenile condition of a "... pitted surface of the bone and incomplete ossification of the articular facets" (Campbell, 1979:17). The measurements taken were as follows:

Cranium greatest length (CGL). Measured as the greatest distance from the *protuberantia occipitalis externa* to the *incisivum*.

Cranium greatest width (CGW). Measured across the *linea nuchales superior*.

Cranium orbital width (COW). Measured as the smallest breadth between of the *pars nasalis* of the *frontale*.

Cranium greatest postfrontal width (CPW). Measured as the greatest breadth across *processus postfrontales*.

Cranium greatest depth (CGD). Measured from the *basisphenoid* in the median plane to the highest and median point of the braincase.

Cranium incisivum width (CIW). Measured as the greatest width at the base of the *incisivum*.

COMPARATIVE MATERIAL

Skeletons (catalogue number, sex, locality) of *Anhinga m. novaehollandiae* are as follows:

Anhinga m. novaehollandiae AMO.62367 ? Australia; AMO.65078 ? Magela Floodplain,

Northern Territory; AMO.65077 ? Magela Floodplain, Northern Territory; AMO.65076 ? Magela Floodplain, Northern Territory; AMO.65075 ? Magela Floodplain, Northern Territory; ANWC (PELS 38) ? Papua New Guinea; ANWC (PELS 316) ? Burrinjuck Dam, New South Wales; ANWC (PELS 318) ? New South Wales; ANWC (PELS 319) ? Burrinjuck Dam, New South Wales; ANWC (PELS 320) ? Burrinjuck Dam, New South Wales; ANWC (PELS 356) ? Woolgarlo, Pincey Ridge, New South Wales; ANWC (PELS 37) ? New South Wales; MV W4754 ? Victoria; MV W5092 ? Victoria; MV W5913 ? Victoria; MV W8972 ? Victoria; MV W12746 ? Victoria; MV W13183 ? Healesville Sanctuary, Victoria; MV B8674 ? Melbourne Zoo, Victoria; MV B8675 ? Reedy Lakes, Kerang, Victoria; MV B11664 ? Reedy Lakes, Kerang, Victoria; MV B16242 ? Top Marsh, Kerang, Victoria; MV B17254 ? Lake Mokoan, Victoria; MV B17255 ? Lake Mokoan, Victoria; MV B17595 ? Lake Mokoan, Victoria; MV B18970 ? Lake Mokoan, Victoria; QM 21032 ? Queensland; QM 21031 ? Queensland; QM 20798 ? Queensland; ROM 157468 ? Australia; SAM 31686 ? Lashmars Lagoon, Kangaroo Island, South Australia.

RESULTS

All cranial measurements of *A. laticeps*, except the cranium orbital width (COW) and the cranium incisivum width (CIW), fall within the observed range of those for extant darters (Table 1). There is a depression in the region of the *pars nasalis* of the frontal bone which is clearly illustrated in Plate VI of De Vis' original description and marked with a small "a" (De Vis, 1906). It runs from the frontal region commencing behind the *processus postfrontalis* and continues through to the *processus frontalis* of the premaxilla. This appears to have been a post-mortem fracture as there is no sign of any bone regrowth. The depression probably contributes to an artificial widening of the interorbital area through the flexure of the orbital bones on either side to accommodate the depressed bone piece. The large cranium orbital width is, therefore, considered to be artefactual.

The cranium incisivum width of *A. laticeps* is not significant at two degrees of freedom and, therefore, not considered to be of taxonomic importance. The cranium of *A. laticeps* lacks most of the features on the dorsal side and retains just a remnant of the basisphenoid rostrum. De Vis

(1906:18) remarked that the "presphenoid rostrum is higher and much stronger than it is in the recent bird." Comparison with the 31 specimens of the living *A. m. novaehollandiae* has shown this feature to be extremely variable and that *A. laticeps* fits well within that variation. In all other cranial features, *A. laticeps* compares very well with the modern *A. m. novaehollandiae*.

COMPARISON WITH FOSSIL MATERIAL

Several specimens of fossil darters were collected from the vicinity of the type locality and identified as *A. laticeps* by R.H. Tedford and his team in the late 1950s. Some of these were reviewed by Miller (1966) and assigned to *A. m. novaehollandiae*. A single vertebra and bone fragment (UCMP 56351), a proximal end of an ulna (UCMP 56319) and a proximal end of a humerus (UCMP 94681) collected by R.H. Tedford from Coopers Creek, all compare well with extant *A. m. novaehollandiae* in both size and features (humerus greatest width: *A. m. novaehollandiae* 22.8mm - 19.4mm (Mackness, unpublished data); *A. laticeps* 20.2mm).

Other *Anhinga* specimens have been collected from the Katipiri Formation of Lake Kununka, eastern Lake Eyre Basin. These were questioned by Vickers-Rich (1991) as being of Pliocene age but are clearly labelled by their collector R.H. Tedford as being from the Katipiri Sands, a Pleistocene deposit. A vertebra (UCMP 112825) is too worn for diagnosis but compares well with the extant *A. m. novaehollandiae* in size as does a cervical vertebra (UCMP 56852). Two proximal ends of humeri (UCMP 60545, greatest width: 18.4mm; UCMP 56885 20.9mm) compare well with extant *A. m. novaehollandiae* in both size and features. A distal end of an ulna (UCMP 60863) from the Pleistocene beds of Warburton River in South Australia is also regarded as inseparable from the extant darter.

DISCUSSION

In his original description of *A. laticeps*, De Vis (1906) compared the fossil with only one specimen of the extant darter *Anhinga m. novaehollandiae*. Miller (1966), in his subsequent revision of Australian darters, used seven specimens of *A. m. novaehollandiae* and two specimens of *A. anhinga*. This study utilised an examination by Mackness (unpublished data) of 56 darter skeletons (12 specimens of *A. anhinga*; 13 of *A. melanogaster rufa* and 31 of the extant

A. m. novaehollandiae) as well as fossil material referred to this taxon. Because of the obvious large size of *A. laticeps*, only *A. m. novaehollandiae*, the largest of the extant darters, was used in the statistical analysis.

Miller (1966:317) supported the retention of *A. laticeps* as a valid species on the basis that "the measurement of *laticeps* exceed the mean of the modern material by more than three times the standard deviations". With a much wider data set, only one of these measurements now falls within this category and that measurement is suspect owing to post-mortem fracturing. Several specimens of extant darter fall outside two degrees of freedom, particularly ANWC (PELS) 316, a large female from Burrinjuck Dam in New South Wales. It is clear that there is significant variation within certain darter measurements and caution should be exercised in making taxonomic decisions before first comparing any specimen with a suitable data set encompassing such variation.

There is not more than one darter species occurring in any one location anywhere in the world within extant populations (Dorst & Mougin, 1979), nor is there any evidence of this in the fossil record (Mackness, in press). With demonstrable specimens of *A. m. novaehollandiae* from the Pleistocene of Australia and a new species of darter from the Pliocene (Mackness, in press), it is unlikely that a second form of darter lived during the Pleistocene. Even if the large interorbital width of *A. laticeps* proves to be not artefactual, the continued recognition of this palaeospecies cannot be justified, and its synonymy with *A. m. novaehollandiae* is the best solution.

ACKNOWLEDGEMENTS

We thank Walter Boles, Australian Museum, and Rory O'Brien, Museum of Victoria for their generous support and assistance during this study. Michael Archer and Suzanne Hand provided helpful comments on the manuscript. Les Christidis, Museum of Victoria; Matthew Shaw, Queensland Museum; Richard Schodde and John Wombey, CSIRO Division of Wildlife and Ecology; A.J. Baker, Royal Ontario Museum; Phillipa Horton, South Australian Museum, made comparative material available. This study was supported in part by an ARC Program Grant to M. Archer; a grant from the Department of Arts, Sport, the Environment, Tourism and Territories to M. Archer, S. Hand and H. Godthelp; a grant from the National Estate Program Grants Scheme to M. Archer and A. Bartholomai; and grants in

aid to the Riversleigh Research Project from Wang Australia, ICI Australia and the Australian Geographic Society.

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A BLUE WHALE *BALAENOPTERA MUSCULUS* (LINNAEUS, 1758) FROM ST LAWRENCE, QUEENSLAND

ROBERT A. PATERSON & STEVE VAN DYCK

Paterson, R.A. & Van Dyck, S.M. 1995 12 01: A blue whale *Balaenoptera musculus* (Linnaeus, 1758) from St Lawrence, Queensland. *Memoirs of the Queensland Museum* 38(2):615-621. Brisbane. ISSN 0079-8835.

The decomposing carcass of a juvenile blue whale *Balaenoptera musculus musculus* (Linnaeus, 1758) washed ashore at St Lawrence, Queensland in February 1994. Its skeleton was retrieved together with some baleen. Comparison was made with its vertebral measurements and those of a pygmy blue whale *B. m. brevipinna*. Pathological changes, possibly post-traumatic, in the caudal vertebrae are described and the sparse records of blue whales in Queensland waters are documented. □ *Blue whales, skeletal and baleen descriptions, Queensland.*

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In late January 1994 the carcass of a large whale was found drifting in Broad Sound by Chris McNamara a local fisherman. It subsequently washed ashore between Waverley and St Lawrence Creeks 11km east of St Lawrence (22°19'S, 149°38'E). On 17 February Grahame Byron of

Queensland Department of Environment and Heritage (Rockhampton) identified it as a large rorqual measuring between 16.5-17.5m in length. The uncertainty in measurement resulted from advanced decomposition and the disposition of the carcass (Fig. 1). Assisted by Peter Cross and



FIG. 1. Carcass of QMJM10415 photographed at low tide on 17 February 1994.



FIG. 2. Carcass of QMJM10415 photographed at high tide on 23 February 1994.

Kel Fowler of Queensland Boating and Fisheries Patrol (Mackay), we retrieved the available skeletal material on 23-24 February and 8 March 1994. (Details of skeletal elements, considered to have been lost prior to collection, will be given later.) The discovery of some baleen 80m from the carcass enabled its identification as a blue whale. The location of the carcass presented considerable logistic difficulties. They included a tidal range of approximately 5.5m on an exposed shore with a steep mud bank lined with living and dead mangroves. Rapid tidal flow posed dangers due to movement of the skull and mandible with their attached soft tissues (Fig. 2). The journey to the nearest boat ramp was 7km. During one journey, with the mandible lashed to the sides of the 5.2m boat and the skull being towed, the nasals and premaxillae became detached and were lost. Despite these and other difficulties the skeleton was transported initially to St Lawrence before its removal to Brisbane. It is registered QMJM10415 in the mammal collection of the Queensland Museum and is the first confirmed record of a blue whale in that collection.

SKELETAL APPRAISAL

Yochem & Leatherwood (1985) consider that blue whales are 6-7m long at birth whereas Slijper (1962) considered that they are approximately 7.5m long at birth which, in the Southern Hemisphere, occurs during May-June. He also noted that weaning occurs at seven months when length averages 16m. Accordingly, QMJM10415 may have died about the time of weaning. The length at physical maturity is 24.5-26.5m (Slijper, 1962) whereas the pygmy form (*B.m. breviceauda*) described by Ichihara (1966) reaches physical maturity at 20-22m.

The skull of QMJM10415 measured 4.32m in length and is shown, from its ventral aspect, in Fig. 3. The left side of the mandible measured 4.34m in length and the right 4.36m. There were fourteen pairs of ribs. The epiphyses of only the first two cervical and last twelve caudal vertebrae were attached to their centra. Fifty-nine vertebrae were collected but there were four additional pairs of central epiphyses making a vertebral count of sixty-three. The appearance and size of the additional epiphyses suggest that the four missing vertebrae are D9, 10, 11 and L2. The



FIG. 3. Skull of QMJM10415 from ventral aspect.

vertebral formula C7; D14; L15; Ca27=63 is consistent with others reported for the species although variations of 63-66 have been noted (Tomilin, 1957; Ichihara, 1966; Omura et al., 1970).

Pathological changes were seen in the spinous processes and neural arches of Ca10-11 (Fig. 4). Considerable hyperostosis was noted but there was no involvement of the centra as seen in spondylitis deformans, considered to be associated with advanced age in cetaceans (Slijper, 1936; Van Bree & Duguy, 1970; Lagier, 1977; Omura, 1972 & 1975; Paterson, 1984; ;). The

degree of hyperostosis, localisation to two vertebrae and lack of associated bony destruction tend to exclude metabolic bone disease, osteomyelitis and recent trauma as causes of these changes. However, trauma in the perinatal period is possible as the advanced hyperostosis is consistent with a process present for months rather than weeks. One of us (RAP) has observed hyperostotic changes localised to two vertebrae (Ca7-8) in a juvenile (central epiphyses unfused) blue whale skeleton in the British Museum of Natural History. The registration number of that specimen is BMNH1865.8.23.1. Slijper (1936) noted examples of similar pathology to that in QMJM10415 in juvenile cetaceans and considered that onset prior to birth was possible, given the extent of the changes.

Omura et al. (1970) demonstrated in tabular and graphic form vertebral measurements of an 18.6m long pygmy blue whale captured at 42°08'S, 44°09'E in December 1966. Its skull measured 4.86m in length. The epiphyses of all vertebrae were fused to the centra. In Fig. 5 the vertebral measurements of that specimen are compared with those of QMJM10415 whose maximum length was 17.5m. The vertebrae of the pygmy blue whale are larger in all respects than those of QMJM10415 with the exception of the lengths of the centra, particularly in the caudal region. This latter finding, admittedly in the context of only two specimens of disparate physical maturity, may be significant in that Ichihara (1966) named the pygmy blue whale *B. m. brevicauda* on the basis that its tail, on external measurement, was relatively shorter than that of *B. m. musculus*.

In addition to the missing vertebrae, discussed above, some other bones were not retrieved and may have washed away prior to our visits to the site. They were the sternum, a stylo-hyal, an ulna and some carpals and metacarpals.

BALEEN

The number of baleen plates reported for blue whales is 324 ± 6 (Mackintosh & Wheeler, 1929). A portion totalling 88 plates from the right baleen row of QMJM10415 was recovered and one of the larger plates is shown in Fig. 6. The lengths of all plates are shown in Fig. 7 and the steep decline in measurements suggests that the plates were from the posterior aspect of the row. Illustrations of complete baleen rows from a large balaenopterid in the British Museum of Natural History (Beddard, 1900) and humpback whales (*Megaptera novaeangliae*) in the Queensland

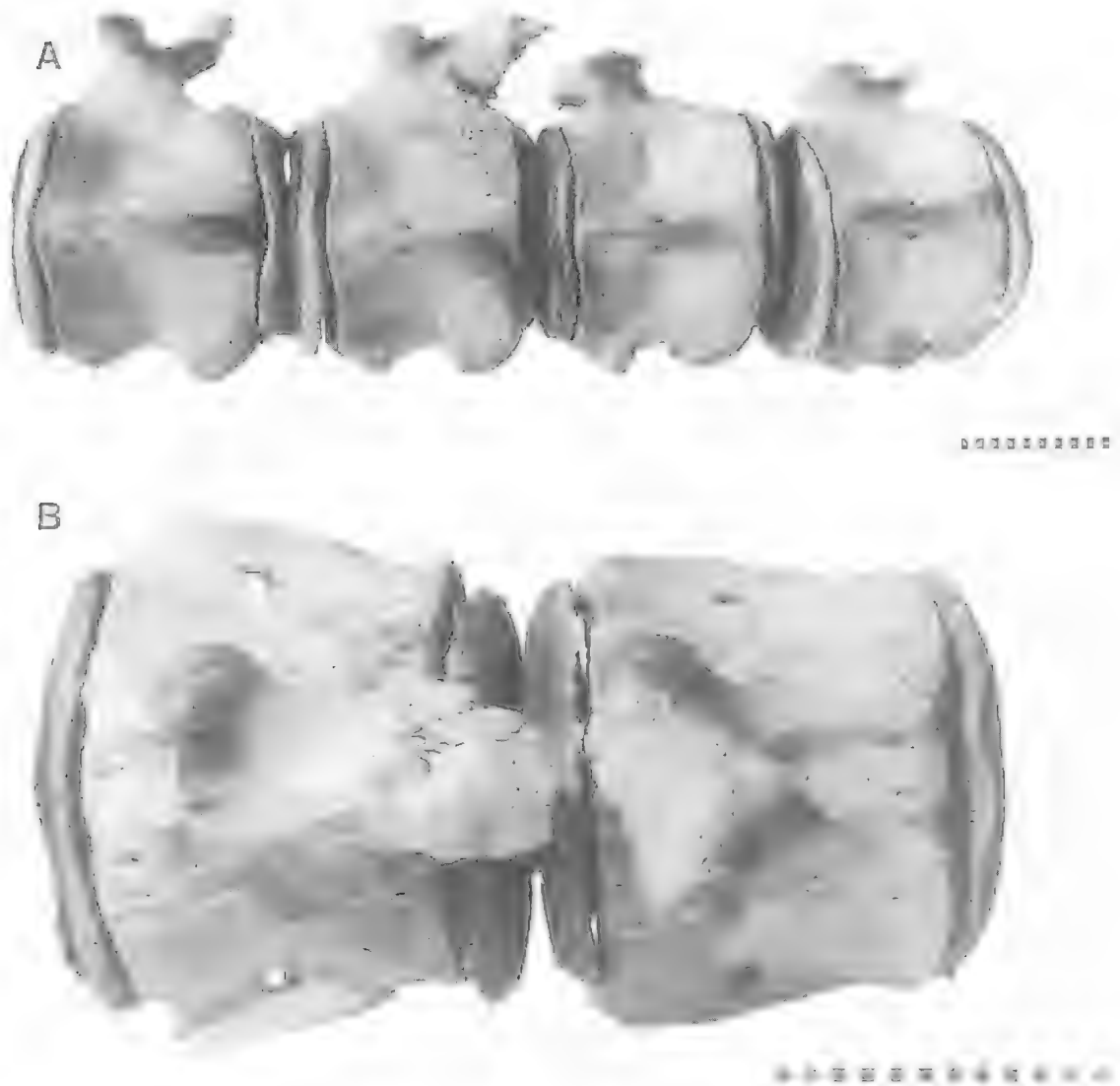


FIG. 4. Caudal vertebrae of QMJM10415 in (A) lateral and (B) dorso-ventral projection. Hyperostoses are seen on the spinous processes and neural arches of Ca 10 and 11. In the fresh specimen the pathological areas were "bridged" by fibrous tissue.

Museum (Paterson & Van Dyck, 1991) demonstrate a much steeper decline in the lengths of the posterior plates than the anterior plates.

Ichihara (1966) measured length/breadth ratios of the largest baleen plates in 77 specimens of *B. m. musculus* and 118 *B. m. breviceauda*. The ratios in the latter did not exceed 1.93 in any specimen.

The equivalent ratio in the largest recovered plate of QMJM10415 is 2.05. Although the plates of QMJM10415 may not include the largest, the ratio of 2.05 suggests that the plate is typical of *B. m. musculus*.

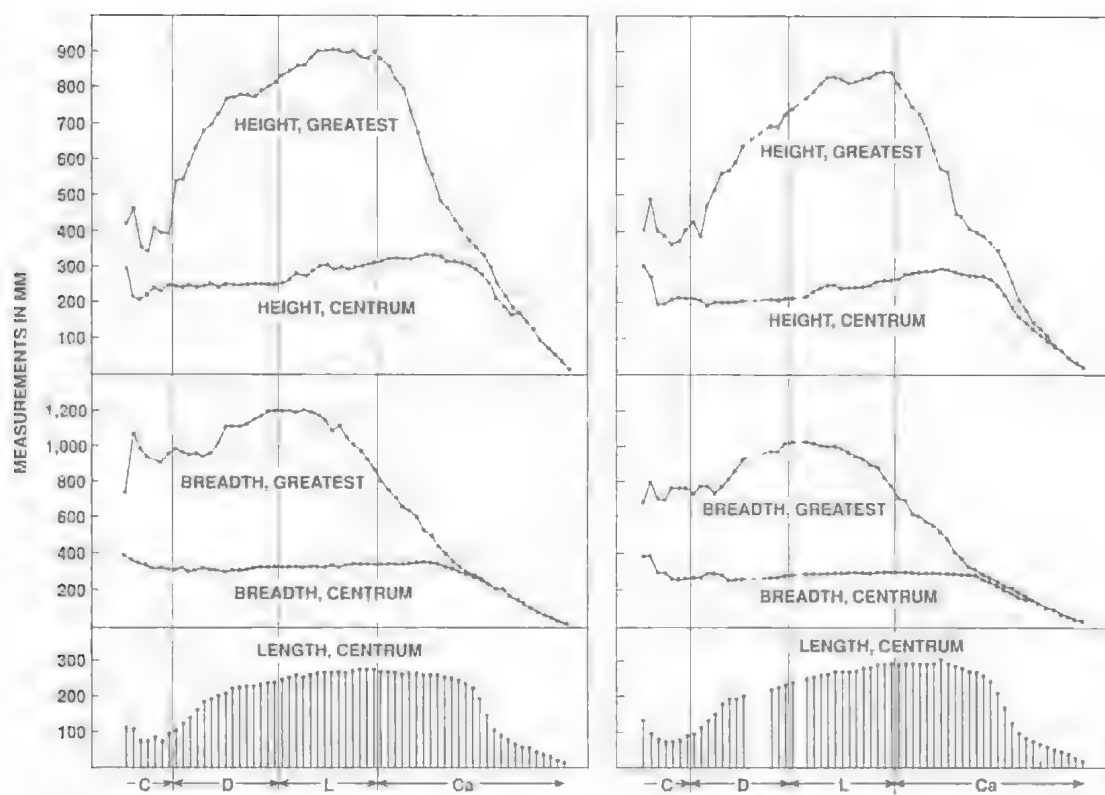


FIG. 5. Comparative vertebral measurements of QMJM10415 (right) and pygmy blue whale (left). The latter measured 18.6m in length and the former 17.5m.

QUEENSLAND BLUE WHALE RECORDS

There is an earlier record of *B. musculus* in the Queensland Museum (Paterson, 1986). The specimen (J4807) is a small portion of baleen from a whale which stranded in 1928 at Couti Uti (22°20'S, 150°08'E) not far from the locality of QMJ10415. However, re-examination of the specimen indicates that it is from a fin whale, *B. physalus* (Linnaeus, 1758). The Queensland Museum also has a photographic record of a large rorqual, possibly a blue whale, which stranded at O'Regan's Creek, Dundowran (25°18'S, 152°46'E) in the late 1930s. Eye witness accounts indicated that the whale exceeded 22m in length (M. Campbell, pers. comm.) and they are supported by the photographic evidence (Fig. 8).

In the period (1952-1962) of whale exploitation from the shore-station at Tangalooma (27°11'S, 153°23'E) 6277 humpback whales were captured and the commercial viability of the station depended exclusively on that species (Chittleborough, 1965). One blue whale measuring 20.5m in length was captured during the 1954 season. In the station's terminal phase a fruitless

search for humpback whales was made at distances exceeding 60km from the coast. During that off-shore search two blue whales were seen (L. Nash, pers. comm.). Paterson et al. (1994) assessed humpback whale population recovery from Point Lookout (27°26'S, 153°33'E) during June-October from 1978-1992 and saw only one blue whale. Identification was made on the basis of the extremely tall blow, which exceeded 10m in height and is considered to be characteristic of the species (Horwood, 1986). These isolated capture, sighting and stranding records suggest that blue whales are infrequent visitors to Queensland coastal waters whereas they are more frequently sighted in the cooler waters of southern Australia (Paterson, 1982) and stranding records are more numerous from those regions (Dixon & Frigo, 1994; Kemper & Ling, 1991).

ACKNOWLEDGEMENTS

We owe particular thanks to Peter Cross and Kel Fowler of QBFP. Without their generous assistance and local knowledge the retrieval

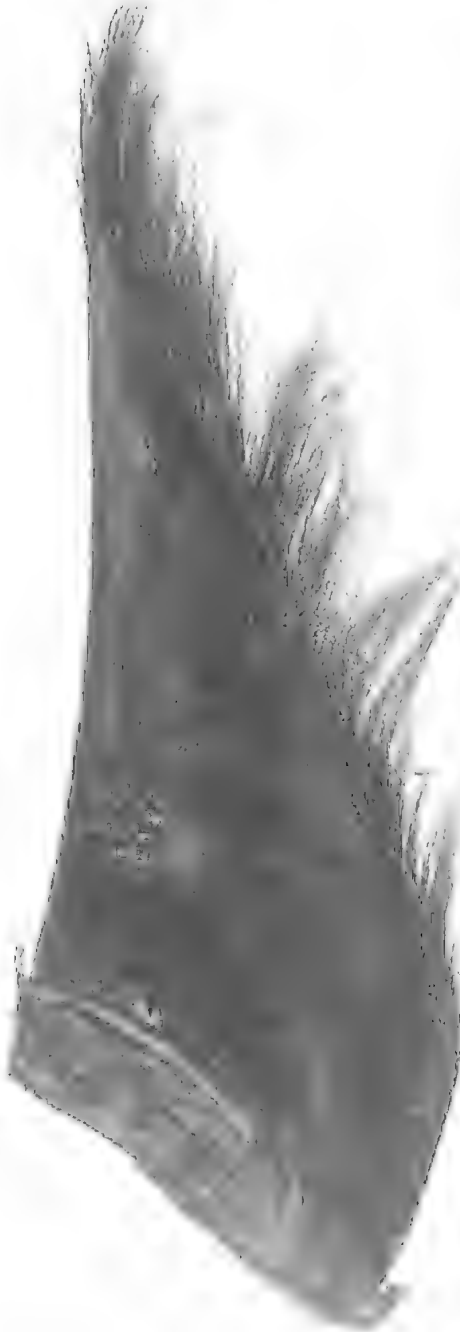


FIG. 6. One of the largest baleen plates of QMJM10415.

would not have been possible. Grahame Byron of QDEH performed the initial inspection and pro-

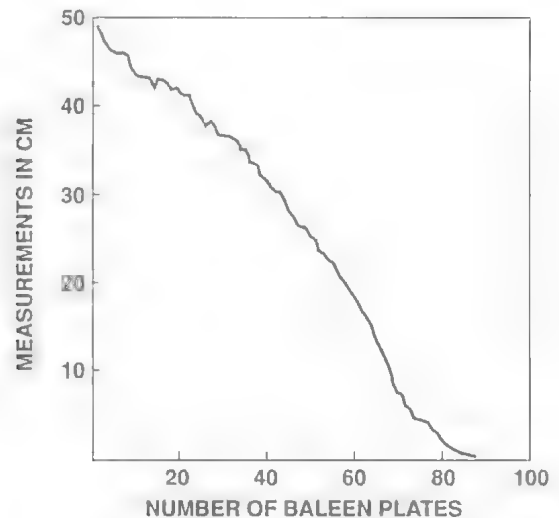


FIG. 7. Graph demonstrating the length of the baleen plates, considered to be from the right posterior row of QMJM10415.

vided Fig. 1. Ben Ingram and Richard McTaggart of the St Lawrence Police Station provided support and staff of the Broadsound Shire Council and Queensland Railways assisted with transport and loading. The hospitality of Ken Johnson and family of the Sportsman's Arms Hotel at St Lawrence was much appreciated. Staff at the Luggage Point Wastewater Treatment Plant at Pinkenba kindly allowed us to store the skeleton there during cleaning and ensured its safety. A generous donation from the Australian Whale Conservation Society defrayed steam-cleaning costs. Bruce Cowell of the Queensland Museum prepared the photographs and Sue Gray prepared the figures.

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FIG. 8. Skeleton of large rorqual, possibly a blue whale, at Dundowran in the 1930s. The skull and mandible are situated in an inverted position, to the right of the photograph.

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FIRST RECORD OF PALAEMON CONCINNUS DANA, 1852 (CRUSTACEA: DECAPODA: PALAEMONIDAE) FROM AUSTRALIA. *Memoirs of the Queensland Museum* 38(2):622. 1995:- *Palaemon concinnus* is widely distributed in the Indo-West Pacific region but has not been previously recorded from Australia, despite being known from neighbouring areas such as New Guinea (Holthuis, 1982) and New Caledonia (Holthuis, 1970). Four specimens collected from Palm Island, northeast Queensland by Mr Hamar Midgley in 1977, were found in the unidentified collections of the Queensland Museum. Further material was discovered at the Northern Fisheries Centre, Cairns, after an invitation by Mr Warren Lee Long (Queensland Department of Primary Industries) to examine and identify Crustacea collected during their Johnstone River Catchment Survey. Abbreviations: QM, Queensland Museum; QDPI, Queensland Department of Primary Industries; NEQ, northeast Queensland. All measurements are carapace length from the orbit to the posterior margin.

Palaemon concinnus Dana, 1852

Restricted synonymy

Palaemon concinnus Dana, 1852: 26.
Palaemon exilimanus Dana, 1852: 26.
Leander longicarpus Stimpson, 1860: 40.
Palaemon lagdoensis Blanco, 1939: 167, pl. 1.
Palaemon (Palaemon) concinnus: Holthuis, 1950: 61, fig. 12.
Palaemon concinnus: Chace & Bruce, 1993: 40.

Material Examined

QMW14793, 2 ♀ (12.6, 12.8mm), Palm Is., airport swamp, NEQ, July 1977, S.H. Midgley; QMW16427, 1 ♂ (9.2mm), 1 ♀ (13.6mm), *Ibid.*; QMW18730, 1 ♂ (19.9mm), 1 ♀ (6.4mm), Bamboo Ck, Innisfail, NEQ, freshwater tidal reach, silt, fringing rainforest, water clarity high, *Vallisneria*, *Blyxa*, *Aponogeton*, fallen timber, leaf litter, DO₂ 60% saturation, 1m depth, electrofished, 1992, QDPI Northern Fisheries Centre, Johnstone R. Catchment Survey; QMW19615, 1 ♀ (8.1mm), unnamed tributary of Johnstone R., NEQ, 17°29.0'S, 146°01.9'E, freshwater, lotic, water temperature 28.2°C, DO₂ 87.0%, turbidity 2.0 NTU, electrofished, 10/4/1992, QDPI Northern Fisheries Centre, Johnstone R. Catchment Survey.

Remarks

Male specimens examined have a rudimentary appendix interna on the endopod of the first male pleopod, a feature that distinguishes *P. concinnus* from other species of the genus. Other diagnostic features such as the rostrum and antennular flagellae also agree well with published descriptions and

figures. Bruce (1987) provided a key to the six species of *Palaemon* previously recorded from Australia - *P. debilis* Dana, 1852; *P. litoreus* (McCulloch, 1909); *P. macrodactylus* Rathbun, 1902; *P. semmelinkii* (de Man, 1881); *P. serenus* (Heller, 1862); and *P. serrifer* (Stimpson, 1860).

This species is recorded in the literature from salt, brackish and freshwater. The Australian records are from coastal lowland fresh waters in the wet tropical region of northeast Queensland.

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John W. Short, Queensland Museum, P.O. Box 3300, South Brisbane, Queensland 4101, Australia; 7 November 1995

THREE NEW MYGALOMORPH SPIDER GENERA FROM THAILAND AND CHINA (ARAENAE)

ROBERT J. RAVEN AND PETER J. SCHWENDINGER

Raven, R.J. & Schwendinger, P.J. 1995 12 01: Three new mygalomorph spider genera from Thailand and China (Araneae). *Memoirs of the Queensland Museum* 38(2). 623-641. Brisbane, ISSN 0079-8835.

Three new mygalomorph genera and four new species are described: *Angka* gen. nov., *Angka hexops* sp. nov., a cyrtacheniid from Thailand; nemesiids, *Sinopesa* gen. nov., *Sinopesa maculata* sp. nov., from Thailand and *Sinopesa guangxi* sp. nov. from China; and a diplurid, *Leptothele* gen. nov., *L. bencha* sp. nov., from Thailand. Generic limits, cladistic assessments and systematic placements within the 3 families are discussed, notes on natural history are given. A character initially considered diagnostic in *Phyxioschema suthepium* Raven & Schwendinger is shown to be variable. □ *Mygalomorphae*, *Angka*, *Sinopesa*, *Leptothele*. China, Thailand.

Robert John Raven, Queensland Museum, PO Box 3300, South Brisbane, Queensland 4101, Australia; Peter J. Schwendinger, Institute of Zoology & Limnology, University of Innsbruck, Technikerstr. 25, A-6020 Innsbruck, Austria; 28 August 1995.

In biodiversity studies, it is customary to compare faunal diversities of regions and countries with one another. Judged by an early catalogue of spiders (e.g. Roewer, 1942), the mygalomorph fauna of Thailand has been poorly represented (2 theraphosids and 1 atypid). The reasons are historical. Early arachnologists focused their collecting efforts on British and other European colonies. The protracted absence of harsh western techniques for land use no doubt ensured that the biodiversity of Thailand was not so heavily affected until World War II but equally it was little known. The prolonged absence of a country so rich and diverse as Thailand from phylogenetic and biogeographic studies of spiders has led to significant weaknesses in such analyses. Wide discontinuities in both form and space invite explanations of rapid evolution in the known fauna, and the intrusion of major barriers and/or cataclysmic extinction. The effect, however, is probably no more detrimental than inadequately funded taxonomy in key regions like India, and was succinctly demonstrated in the New Zealand area by *Sphenodon* (Daugherty et al., 1990) where subspecies became extinct because of the limited taxonomic study on the genus.

This paper is one of several (by PJS with others) on the spiders of the rich forests of Thailand and highlights these points. The Aganippinae were thought to be highly specialised endemic Australian taxa (e.g. Main, 1981) with the closest relatives being the Indian genysine genus *Scalidognathus* Karsch, 1878 (Raven, 1985). The description of *Prothemenops* Schwendinger, 1991 from Thailand removed the

mystery of that uniqueness and quickly bridged the gap. Here we address further exciting new species of initially uncertain taxonomic status discovered in Thailand. Relationships became clear by searching for sister taxa. For each species a new genus is established; in one, a new species from China is also included. The new taxa show new relationships among southeast Asian and Australian mygalomorphs.

MATERIALS AND METHODS

Abbreviations are standard for the Araneae and follow Raven (1994). Number of structures on the opposite body side are given in parentheses. Measurements, if not otherwise indicated, are in mm; total length includes chelicerae. Colour is described from alcohol preserved specimens unless noted. Museum Acronyms: MCZ, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; MHNG, Muséum d'Histoire naturelle, Genève; NHMW, Naturhistorisches Museum, Wien; QM, Queensland Museum, Brisbane. Collectors: AP, A. Payne; PJS, P.J. Schwendinger.

SYSTEMATICS

Family CYRTAUCHENIIDAE Simon

RELATIONSHIPS

This group was given family status first by Raven (1985) who radically restructured the Mygalomorphae. Only Goloboff (1993) has since addressed the weaknesses of the family tentiously

constituted by Raven (1985). Goloboff's fine analysis used a rigorous method and exhaustive tested alternatives. Goloboff found only some of Raven's groups could be supported but that "Raven (1985) was impressively close to an optimal solution". However, Goloboff (1993) concluded that "the present results were too preliminary to warrant nomenclatural changes". Hence, the classification of Raven is followed here.

Angka gen. nov.

TYPE SPECIES

Angka hexops sp. nov.

DIAGNOSIS

Closely related to *Kiama* Main & Mascord, 1969 but only 6 eyes (Fig. 6I), a narrow fovea (Fig. 6A) and much smaller PMS (Fig. 6K).

Maxillae narrow, ventral surface not distended. Labium short; posterior sternal sigilla small, marginal. Legs armed with spines, also on dorsal tibiae and metatarsi of posterior legs. Legs of ♀ scopulate. Transverse ridges on trichobothrial bases confined to upper ledge (Fig. 4A). Tarsal organ low. Female with 2 rows of teeth on all paired claws (Fig. 3A, D). PMS very small. Metatarsi of ♂ leg I modified (Fig. 6H). Male palp with dorsal spines on tibia and tarsus; bulb with corkscrew-shaped embolus (Fig. 6C, D).

DESCRIPTION

Carapace wide, glabrous; cephalic part wide in front and moderately arched (Fig. 6A, F, J). Group of 6 eyes, not on tubercle, occupies 1/3-1/4 of head width at that point, no PME. Fovea slightly procurved, deep, transverse, narrow. Chelicera robust, with teeth only on promargin of fang groove; rastellum absent. Maxillae moderately wide, with flat ventral surface and few spin-

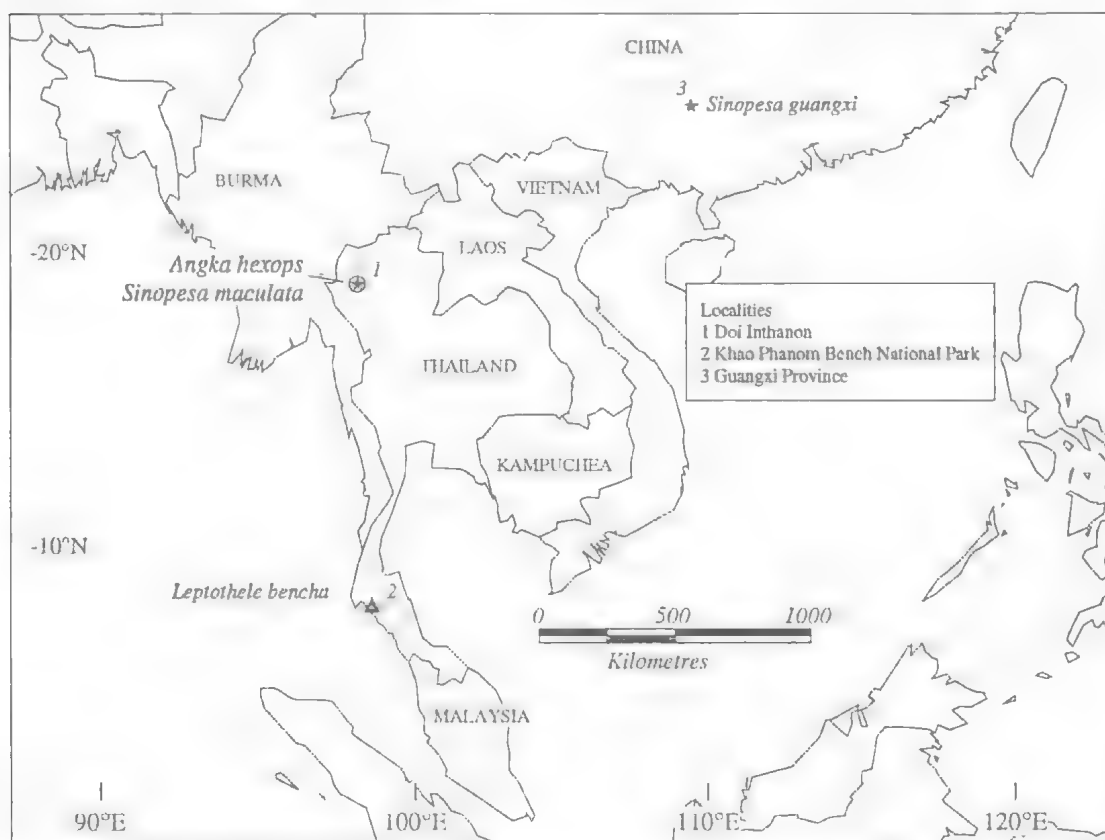


FIG. 1. Occurrence of *Angka hexops* sp. nov., *Leptothele bencha* sp. nov., *Sinopsea maculata* sp. nov. in Thailand and *S. guangxi* sp. nov. in China.



FIG 2. A-C. Habitus. A, B, *Angka hexops* sp. nov. A, juvenile ♂. B, ♀. C, *Leptothele bencha* sp. nov., ♀.

dle-shaped cuspules on probasal corner. Labium wide, short, no cuspules. Sternum almost as wide as long; labiosternal suture a broad groove; all sternal sigilla small, marginal. Legs long, slender; cuticle of distal leg segments with fine reticulated texture (Fig. 5B). Strong spines ventrally on all tibiae and metatarsi and on dorsal side of legs III, IV and on palpal tibia and tarsus. Leg tarsi aspinose. Scopula light on leg tarsi and distal metatarsi of I, II. No preening combs. Trichobothrial collar with transverse ridges only along upper ledge (Fig. 5B). Tarsal organ low, with detached low mounds nearby (Fig. 4A). Paired tarsal claws with 2 rows of several long juxtaposed cylindrical teeth, less numerous and long on III, IV (Fig. 3A, D). Unpaired claw bare, short and hooked. Abdomen pale, no pattern. Booklung apertures with many setae on tissue just inside entrances. PMS very small; PLS long, apical joint digitiform. Pumpkiniform spigots absent.

Male: strong spines but no coupling spur on tibia I (Fig. 6G); metatarsus I sigmoid, aspinose and narrowed in its basal half (Fig. 6B, G); bulb pyriform, with long slender corkscrew-shaped embolus (Fig. 6C, D). No interchelicer al tumescence.

Vulva with 2 spermathecae, each divided into two anterior lobes, the outer ones branching from the distal portion of the spermatheca and bent towards the anterior (Fig. 6L).

ETYMOLOGY

From the type locality, Doi Angka Luang, the old name of Doi Inthanon; *ang ka* Thai, meaning crow's bowl. (Doi = mountain, luang = large, great).

DISTRIBUTION

As for species.

INCLUDED SPECIES

Angka hexops sp. nov.

RELATIONSHIPS

The search for the sister group of *Angka* begins by eliminating alternatives. Several mygalomorph families have strong autapomorphies not present in *Angka*. Two possible families with close affinities are Nemesiidae and Cyrtachenidae. The arched cephalic area and reduced eye tubercle clearly associate *Angka* with the Cyrtachenidae. No nemesiids with such deep and rounded maxillae are known. The similarly elevated tarsal organs of *Kiama* (see Raven, 1981b and Fig. 5C) and *Angka* (Fig. 4A), the elevated caput and sessile eyes, the wide shape of the maxillae, and leg spination indicate they are sister groups. Differences between the two are not phylogenetically contradictory. The strongly procurved fovea of *Kiama* is plesiomorphic for the Rastelloidina (Raven, 1985) and its large sternal sigilla are simply autapomorphic. In both genera, the spermathecae are bilobed "1 + 1" (see Raven, 1985), ♂ lack a tibial spur, and the spiders are light coloured, not dark as for many burrowing mygalomorphs.

BIOGEOGRAPHY

Although *Angka* and the Australian *Kiama* are considered sister groups, the suggestion that their occurrence in Australia arose by invasions through New Guinea (e.g. according to Main, 1981, 1982, Queensland was invaded by idiopids,

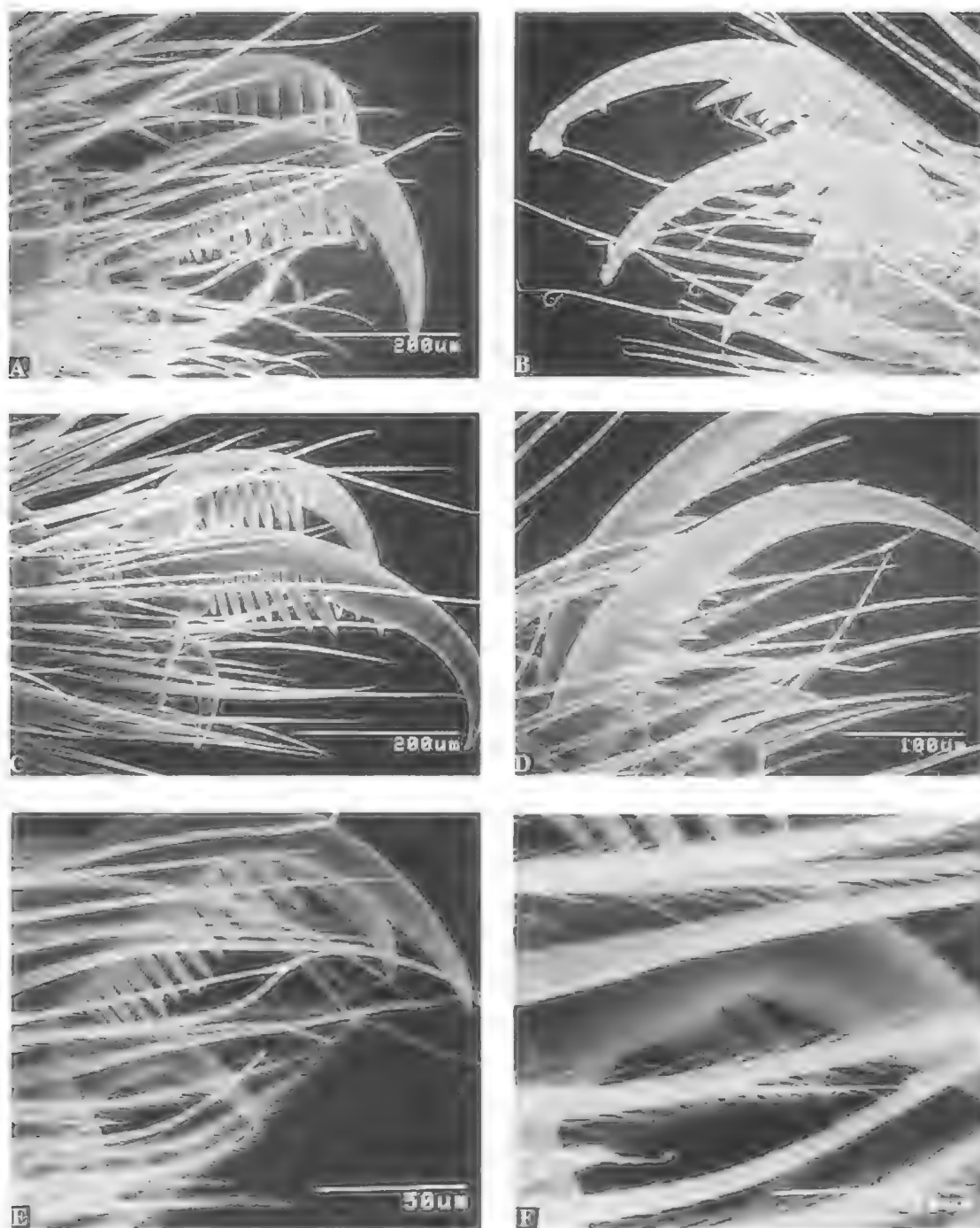


FIG. 3. A-F, Tarsal claws, lateral views. A, D, *Angka hexops* sp. nov. A, ♂, leg I. D, ♀, leg IV. B, C, *Sinopesa maculata* sp. nov., ♂, leg IV. C, *S. guangxi* sp. nov., ♂, leg IV. E, F, *Leptothele bencha* sp. nov., ♀, leg I. E, all claws. F, unpaired claw.

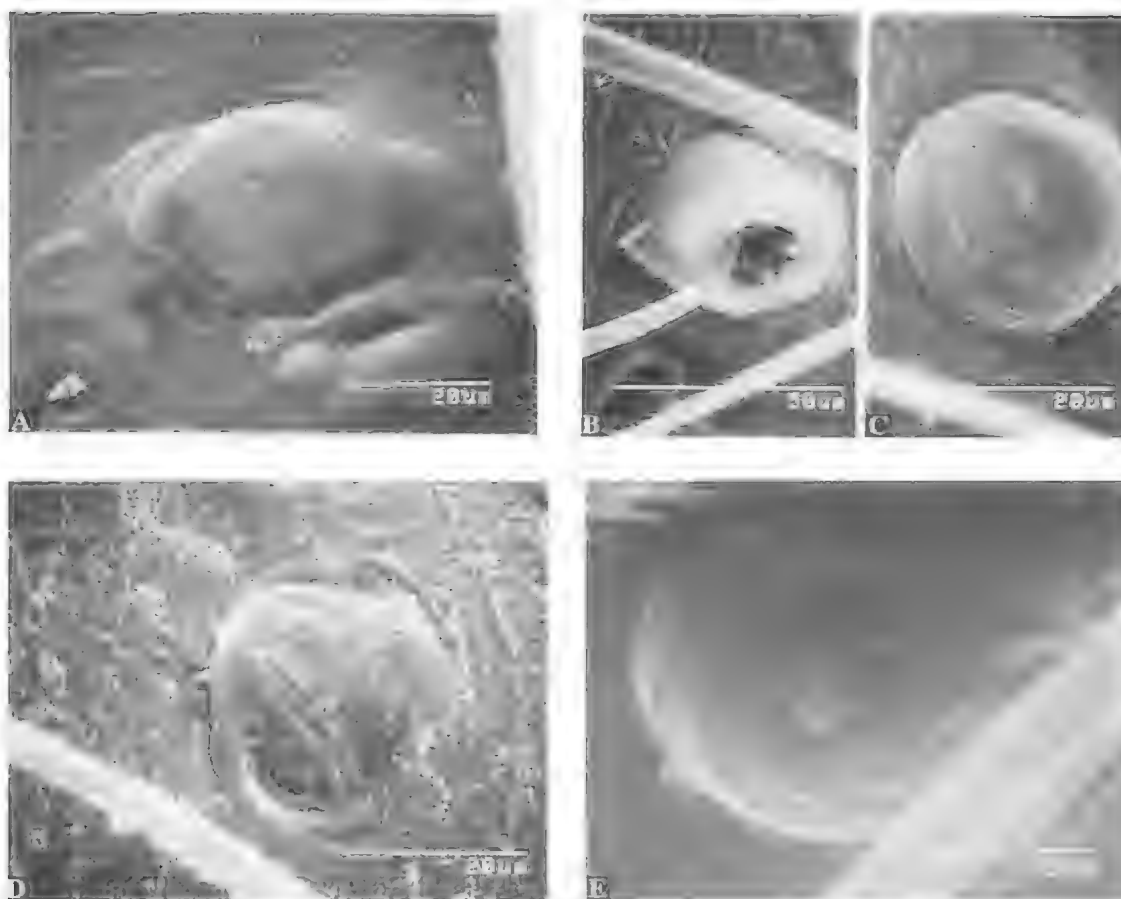


FIG. 4. A-E, tarsal organ, and trichobothrial base, dorsal views. A, *Angka hexops* sp. nov., ♂, leg I. B-D, *Sinopesa*. B, C, *S. guangxi* sp. nov., ♂, leg IV. B, trichobothrium and base, C, tarsal organ. D, *S. maculata* sp. nov., ♂, leg IV. E, *Leptothele bencha* sp. nov., ♀, leg I.

theraphosids, and some barychelids) lacks merit. The taxonomy, distributions, and family placements of mygalomorphs in Main (1982) were tentative and some were confused. Hexathelidae (notably the Atracinae) are not known from New Guinea. Main (1982) noted doubts in locality records of the Chevert Expedition (Rainbow, 1920). In fact, the combination of mygalomorph genera listed from Bradley's Chevert material is exactly that of his home suburb in Sydney, Australia.

Mygalomorph genera known from New Guinea are from Barychelidae (*Nihoa*, *Monodontium*; Raven, 1994), Ctenizidae (*Conothele*; Main, 1982), Dipluridae (*Masteria* Koch, 1873; Raven, 1979) or Theraphosidae (*Selenocosmia*, *Phlogiellus*, *Coremiocnemis*; Queensland Museum records). A similarly botanically diverse region as New Guinea is the Wet

Tropics World Heritage Area (WHA), in north-eastern Australia. Queensland Museum database records (unpublished) list 9 mygalomorph families and 24 genera from the Wet Tropics WHA: Actinopodidae (*Missulena*), Barychelidae (*Idi octis*, *Idiommatia*, *Mandjelia*, *Moruga*, *Ozicrypta*, *Trittame*, *Tungari*, *Zophorame*), Ctenizidae (*Conothele*), Dipluridae (*Cethegus*, *Masteria*, *Namirea*), Hexathelidae (*Hadronyche*), Idiopidae (*Cataxia*, *Homogona*, *Misgolas*), Migidae (*Migas*), Nemesiidae (*Aname*, *Chenistonia*, *Namea*) and Theraphosidae (*Phlogiellus*, *Selenocosmia*, *Selenotypus*). Hence, the known mygalomorph fauna of New Guinea can be regarded as depauperate. Also, the terrestrial component of New Guinea is geologically young, having been pushed up in the Oligocene by the collision of the Australian and Asian plates (Raven & Axelrod, 1972). The three most diverse



FIG. 5. A-G, trichobothrial base and cuticle, oblique dorsal view. A, C, *Kiama lachrymoides* Main & Mascord, ♂. A, trichobothrium & base. C, with tarsal organ & cuticle. B, *Angka hexops* sp. nov., ♂, leg I. D, E, *Acontius* species, ♂, D, leg I, trichobothrial base, dorsal view. E, claws, lateral view. F, G, *Leptothele bencha* sp. nov., F, serrula, axial view. G, maxilla, ventral view.

mygalomorph families in Australia (Idiopidae, Nemesiidae, Barychelidae) are either absent (Idiopidae, Nemesiidae) or far less diverse (Barychelidae: 3 genera vs 10 in Eastern Australia). Significantly, Idiopidae and Nemesiidae occur west of Wallace's Line but not east until

Australia. Equally, few Australian mygalomorphs show affinities with Oriental taxa indicative of dispersal. Large Australian theraphosids of the genera *Selenocosmia* and *Phlogiellus* are widespread through northern Australia and are found also in New Guinea, parts

of the Pacific and southeast Asia. The enigmatic minute litter mygalomorph *Masteria* is known from the Philippines, through the Pacific (northern Australia, New Guinea, Fiji, and New Caledonia) to South and Central America (Raven, 1979, 1991). The group probably predates the breakup of Gondwanaland. The ctenizid *Conothele* occurs through the western Pacific and much of northern Australia. In the Australian Barychelidae (Raven, 1994), only the Indo-Pacific genera *Sason* and *Idioctis* (Raven, 1986, 1988) occur on both sides of Wallace's line.

One alternative for this widely split distribution of the Cyrtaucheniidae lies in India's northward raft carrying part of the fauna including the ancestral sister group of both *Kiama* and *Angka*. After the separation, each genus diverged.

***Angka hexops* sp. nov.**

(Figs 1, 2A, B, 3A, D, 4A, 5B, 6)

MATERIAL EXAMINED

HOLOTYPE: QMS4167, ♂, Doi Inthanon, 18°33'N, 98°28'E, 2530m altitude, Chiang Mai Province, Thailand, 18 Apr-23 May 1987, PJS.

PARATYPES: QMS29274, same data as holotype: 9 ♂♂, 1 ♀, 1 penultimate ♂, 13 Jan 1993, MHNG, NHMW.

ETYMOLOGY

Greek, *hexa* (six), and *ops* (eye).

DIAGNOSIS

As for genus.

DESCRIPTION

Holotype male QMS4167: Total length, 12.5. Carapace 5.2 long, 4.9 wide. Abdomen 5.6 long, 3.7 wide.

Carapace orange brown, chelicerae, palps and leg I red brown, other legs orange brown. Abdomen entirely pallid yellow brown, posterior lung covers with tiny dark patches at bases of setae.

Carapace broad with many long brown bristles on lateral and posterior margins, posterior interstitial ridges, in foveal region, along anteromedial ridge, on clypeus, between PME, and on caput behind eye group. Pars cephalica broad, arched. Fovea deep, slightly procurved, 0.94 wide, occupies ca. 1/5 of carapace width at that point. Clypeus very narrow, 0.25 wide.

Eyes six, PME absent, lateral eyes evanescent, unpigmented; tubercle absent, AME on common mound. Group 0.42 long, front width 1.07, back width 1.10, occupies ca. 1/3 of headwidth. Sizes and interdistances: AME 0.20, ALE 0.21, PME

absent, PLE 0.14; AME-AME 0.15, AME-ALE 0.08, PLE-PLE 0.77, ALE-PLE 0.08.

Chelicerae porrect, broad, with broad band of stiff black bristles dorsally and narrower band of shorter bristles laterally. Intercheliceral tumescence and rastellum absent; rastellar region with fine bristles only. Furrow promargin with 12(13) teeth, basomesally with 3 tiny denticles. Maxillae broad, 1.64 long in front, 2.40 behind, 1.20 wide, with 21-25 cuspules in small prolateral-proximal corner; heel rounded; anterior lobe indistinct. Serrula region with small low scales. Labium 0.60 long, 1.00 wide; no cuspules.

Sternum 2.60 long, 2.60 wide; sigilla distinct, oval, marginal. Labiosternal suture, two tear-shaped sigilla just touching medially.

Leg formula 4123. Eight thorn spines on ventral and prolateral tibia I. Leg I much thicker than II-IV. Metatarsus I slightly sigmoid. Preening combs absent. Anterior leg tarsi slightly spindle-shaped, all aspinose. Scopula light on tarsi and distal metatarsi of legs I, II. Spines: I, fe p1, d1 w, pa 0, ti p2, v4 + 2 megaspines, me 0; II, fe p3, d1 w, pa 0, ti p3, v3, me p1, v7; III, fe all weak, p2, d1, r1, pa p1, ti p2, d1, r2, v7, me p4, r4, v6; IV, fe d1, r1, pa r1, ti p3, r2, v7, me p4 r3 v7; palp, fe p1, pa 0, ti p3 v6, cymbium 6. Trichobothria on legs I-IV and palp: tarsi 8-10 in zig-zag row, metatarsi 10-11 in one straight row, tibiae 6-9 in two proximally divergent rows. Paired claws with two rows of 8-11 teeth; unpaired claws bare.

Leg and palp measurements:

	I	II	III	IV	Palp
Femur	4.75	4.25	3.75	4.68	3.06
Patella	2.81	2.31	2.12	2.12	1.75
Tibia	3.94	3.31	2.43	3.50	2.18
Metatarsus	3.31	2.94	3.18	4.50	-
Tarsus	1.87	1.68	1.68	1.87	0.96
Total	16.68	14.49	13.16	16.67	6.03

Palpal tarsus spinose, with two rounded lobes. Bulb pyriform, embolus long and slender, with corkscrew-shaped tip.

PMS small, 0.27 long, 0.13 wide. PLS 2.1 long; apical segment digitiform, 0.87 and 0.45 mid-width, median 0.50, basal 0.77 long.

Paratype female QMS29274: Total length, including chelicera 15. Carapace 4.9 long, 4.0 wide. Abdomen 7.4 long, 4.7 wide. As in ♂ except:

Body generally pale yellow brown, chelicera and sternum slightly darker.

Carapace glabrous with distinct black bristles along margins and on caput. Caput more distinctly raised than in ♂, highest well behind eyes. Fovea slightly procurved, 0.9 wide, occupies 1/4 of carapace width at that point.

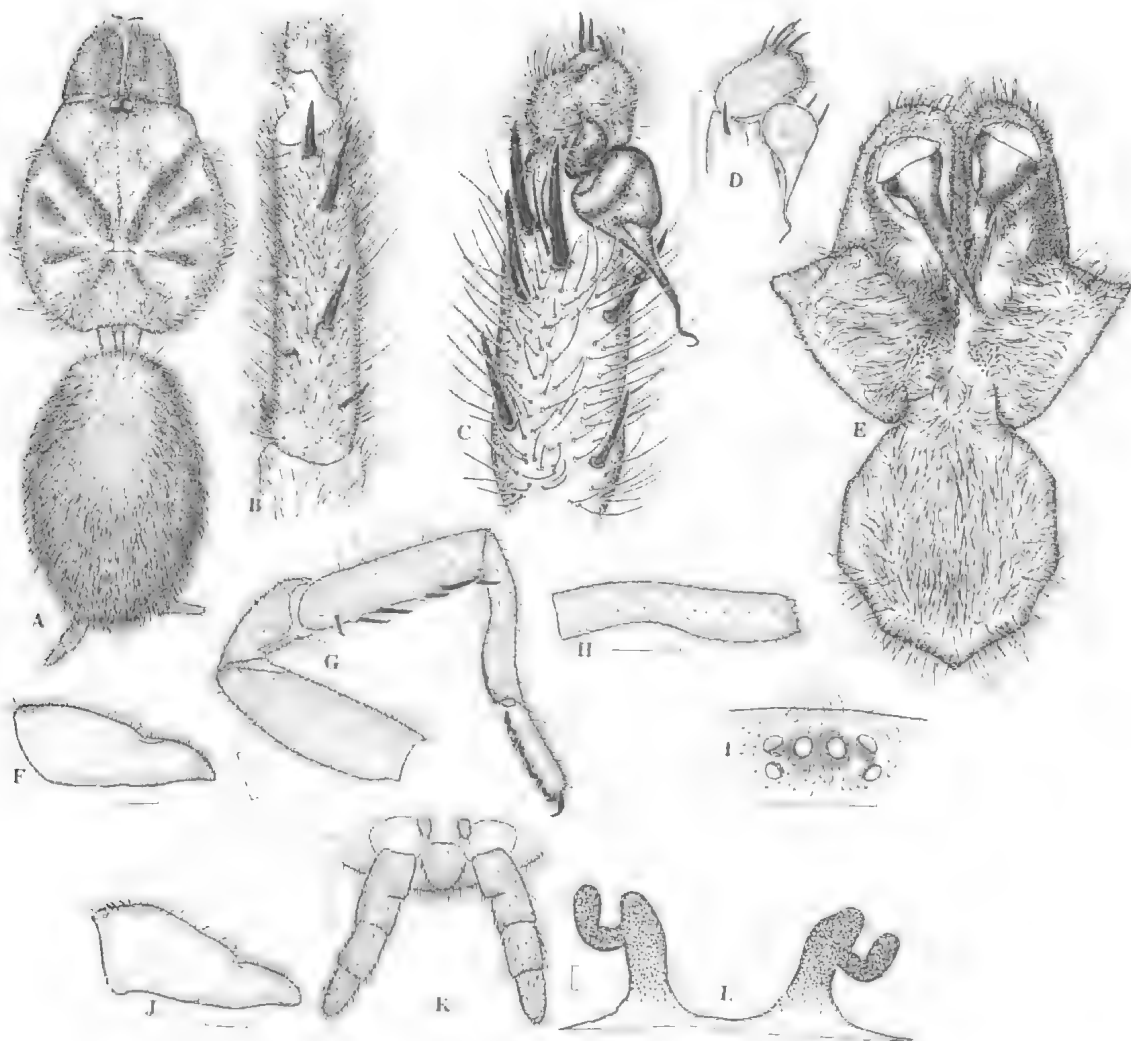


FIG. 6. A-L. *Angka hexops* sp. nov. A-I, ♂. J-L, ♀. A, body (no legs), dorsal view. B, tibia and metatarsus, I, ventral right, ventral view. C, D, palpal tibia, tarsus and bulb. C, ventral view. D, prolateral view. E, chelicerae, sternum, maxillae and labium, ventral view. F, carapace, lateral view. G, leg I, ventral right, prolateral view. H, metatarsus I, dorsal view. I, eyes dorsal view. J, carapace, lateral view. K, spinnerets, ventral view. L, spermathecae, dorsal view. Scale lines = 1.0mm (A-K), 0.1mm (L).

Eye group 0.26 long, front width 0.85, back width 0.84, occupies *ca.* 1/4 of headwidth at that point. Only AME distinct; others small, translucent. Sizes and interdistances: AME 0.14, ALE 0.14, PME 0.04, very indistinct and present only

on left side, PLE 0.06; AME-AME 0.09, AME-ALE 0.08, PLE-PLE 0.69, ALE-PLE 0.05.

Chelicerae strong, 2.3 long, no rastellum; furrow with 13 teeth on promargin and 2(3) basomesal denticles. Maxillae 1.2 wide, front length 1.6, back length 2.1, with *ca.* 30 cuspules

on distinct mound on prolateral-proximal corner. Labium 0.5 long, 1.0 wide; no cuspules. Sternum 2.2 long, 2.2 wide. Posterior sigilla distinct, oval, 0.25 long; others indistinct, submarginal.

Leg and palp measurements:

	I	II	III	IV	Palp
Femur	3.5	3.1	2.8	3.7	3.0
Patella	2.1	1.9	1.7	1.9	1.6
Tibia	2.7	2.2	1.9	2.6	1.8
Metatarsus	1.9	1.9	2.3	3.2	-
Tarsus	1.4	1.4	1.4	1.7	1.7
Total	11.6	10.5	10.1	13.1	8.1

Leg formula 4123. All tarsi apinose. Scopula light on tarsi and distal metatarsi of leg I, II. Spines: I, ti v3(4), me v6; II, ti v4, p1(2), me v7, p1; III, ti v4(5), r1(2), p2(3), d1, me v7, r3, p3, d1; IV, ti v6 (weak), r1, p1, d1, me v7, r3, p2(3), d1; palp, ti v6, ta v3. Trichobothria on legs I-IV (palp): tarsi 10-12 (7-8) in a zig-zag row, metatarsi 9-11 in one straight row, tibiae 7-11 (7) in two proximally divergent rows. Claws with two rows of 6-8 cylindrical teeth, confined to basal portion of paired claws; unpaired claws bare. Palpal claw with prolateral row of 6 teeth.

PMS 0.3 long, PLS 1.9 long; apical segment digitiform, 0.6, median 0.5, basal 0.8 long.

Spermathecae two, each divided into short inner lobe and longer, bent outer lobe.

VARIATION

Carapace lengths of ♂, 4.8-6.1 (n=10). Some ♂ have one PLE reduced. The juvenile ♀ shows small pigmentation where the left PME would be situated. In the mature ♀, a reduced cornea of the PME occurs on the left side.

DISTRIBUTION, HABITAT & BURROW

Known only from cloud forest near the summit of Doi Inthanon (2565m), Chiang Mai Province, Thailand. Female and juveniles were found under rotten logs on the forest floor; ♂ were trapped in pitfalls. In captivity, the mature ♀ built a 6cm long burrow without any silk lining. The only silk observed was a thin web spun onto the substratum before the burrow was made. No other specimens were observed to produce silk or construct a burrow. Two possibilities emerge: the spiders may inhabit temporary retreats and possibly forage on the ground. Vagrant females, however, were not caught in any of the 5 pitfalls at the locality during the 14 month study. Or, as in the case of *Xamiatius rubrifrons* Raven, 1981, only small amounts of web may be used to line the burrow (Raven, 1981b).

Family NEMESIIDAE Simon
Subfamily ANAMINAE Simon

Sinopesa gen. nov.

TYPE SPECIES

Sinopesa maculata sp. nov.

DIAGNOSIS

Sinopesa is close to *Entypesa* Simon, 1902, but differs in lacking posterior median spinnerets (Figs 7J, 8B) and a serrula; in ♂, the palpal tarsus is short (Fig. 7D-F), metatarsus I modified (Figs 7K, 8E), and the interchelicerar tumescence is absent.

DESCRIPTION

Carapace glabrous, narrow in front, caput a little higher than thoracic region in ♂ (Fig. 7B), clearly arched and higher in ♀ (Fig. 7C). Eight eyes on low but distinct tubercle. Fovea deep, very narrow, transverse and slightly recurved. Chelicera weak, with teeth only on promargin of fang furrow. Interchelicerar tumescence and rastellum absent. Maxillae long, narrow, with distinct posterior heel and few cuspules on probasal corner, not on mound; no serrula. Labiosternal suture a broad groove. Sternum wide, with small, marginal sigilla (Figs 7M, 8D). Legs long, slender, strongly armed with spines on patellae to metatarsi, except on dorsal side of legs I, II. Leg tarsi aspinose. Scopula weak on tarsi I, II and distal metatarsi. No preening combs. Paired claws with 2 rows of several long, cylindrical teeth; unpaired claw bare, quite long and little bent. Tarsal organ low (Fig. 4B-D). Trichobothrial base with transverse ridges confined to upper ledge (Fig. 4B). Leg cuticle with fine scaly sculpture (Fig. 4C, D). Abdomen with or without pattern. PMS absent; PLS long, apical article digitiform (Figs 7J, 8A, B). Males with large spines but no spur on tarsus I; metatarsus I sigmoid, narrowed in its basal half, with one distoventral spine (Figs 7H, K, L, 8E). ♂ palp with spines on tibia and dorsal tarsus. Embolus pyriform, with long, slender, more or less corkscrew-shaped embolus tip (Figs 7D-F, 8C).

ETYMOLOGY

The generic name is an arbitrary combination of letters. The gender is feminine.

INCLUDED SPECIES

Sinopesa maculata sp. nov.
Sinopesa guangxi sp. nov.

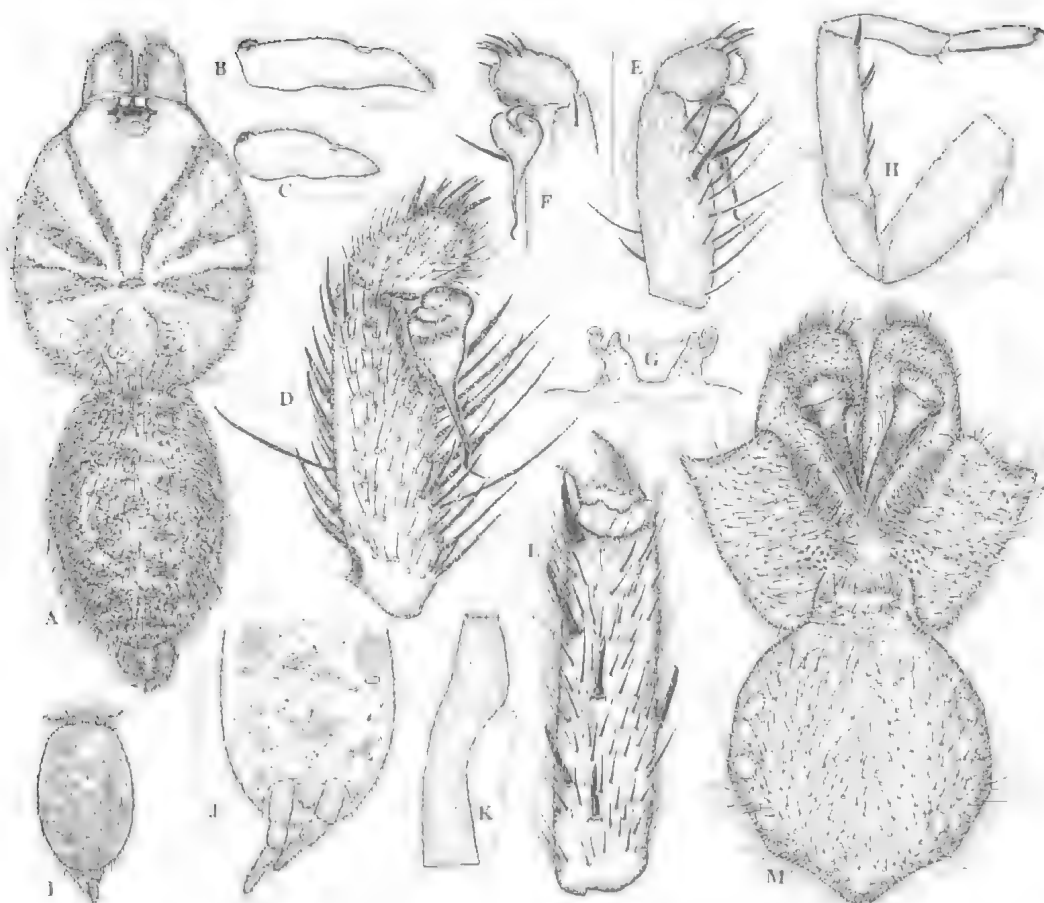


FIG. 7. A-M. *Sinopesa maculata* sp. nov., C, G, I, J, ♀; rest, ♂. A, body no legs, dorsal view. B, C, carapace, lateral view. B, ♂. C, ♀. D, palpal tibia, tarsus and bulb. D, E, retrolateral view. F, prolateral view. G, spermathecae, dorsal view. H, leg I, retrolateral view. I, J, abdomen. ♀. I, dorsal. J, ventral. K, metatarsus I, ♂, dorsal view. L, tibia and metatarsus I, retroventral view. M, chelicerae, sternum, maxillae and labium, ventral view. Scale lines = 1.0mm, except G, 0.1mm.

***Sinopesa maculata* sp. nov.**
(Figs 1, 3B, 4D, 7)

MATERIAL EXAMINED

HOLOTYPE: QMS6207, ♂, Doi Inthanon, 18°33'N, 98°28'E, 2300m altitude, Chiang Mai Province, Thailand, 14 Jul-20 Aug 1987; PJS.

PARATYPES: QMS6208, 1 ♀, 23 May 1987; 3 ♂♂, 14 Jul-20 Aug 1987 & 20 Aug-8 Oct 1987, PJS, MHNG, NHMW.

DIAGNOSIS

Males of *S. maculata* are much smaller than those of *S. guangxi* sp. nov., have a dark pattern dorsally and ventrally and the embolus tip is distinctly corkscrew-shaped.

ETYMOLOGY

Latin, *maculatus*, spotted.

DESCRIPTION

Holotype male QMS6207: Total length, 7.7. Carapace 3.4 long, 3.0 wide. Abdomen 3.4 long, 2.3 wide.

Prosoma, legs and palps brown; abdomen light brown, with dark dorsal and ventral (less pronounced) pattern and dark brown posterior lung covers (Fig. 7J).

Caput low, narrow. Fovea short, slightly re-curved, 0.25 wide, occupies c. 1/12 of carapace width at that point (Fig. 7A).

Eye group on distinct tubercle, 0.31 long, front width 0.61, back width 0.63, occupies slightly less than 1/2 of head width. Sizes and interdistances: AME 0.12, ALE 0.18, PME 0.12, PLE 0.14; AME-AME 0.08, AME-ALE 0.02, PME-PME 0.21, PME-PLE 0.02, ALE-PLE 0.04. MOQ 0.27 long, front width 0.26, back width 0.41.

Chelicerae 0.7 long, no rastellum; furrow with 9(10) teeth on promargin and 5 tiny basomesal denticles. Maxillae 0.6 wide, front length 1.0, back length 1.3, with 14 cuspules at prolateral-proximal corner. Labium 0.2 long, 0.6 wide, no cuspules. Sternum 1.7 long, 1.6 wide. Labioster-nal suture a broad groove.

Leg and palp measurements:

	I	II	III	IV	Palp
Femur	2.7	2.3	2.1	2.8	1.7
Patella	1.7	1.4	1.3	1.4	1.0
Tibia	2.1	1.7	1.4	2.2	1.3
Metatarsus	1.8	1.7	2.1	3.0	-
Tarsus	1.1	1.2	1.3	1.4	0.6
Total	9.4	8.3	8.2	10.8	4.6

Leg formula 4123. Six thorn-like spines on ventral tibia I (Fig. 7H, L). Metatarsus I sigmoid, with distinct prolateral flattening distally (Fig. 7K). Preening combs absent. Tarsi aspinose. Scopula very light on metatarsi and tarsi I, II. Spines: I, fe p1, d3, r1, pa 0, ti p3, v5, me p2; II, fe p3, d4, pa p1, ti p3, v6, me p1, v6; III, fe p3, d3, r2, pa p4 r2, ti p3, d2, r3, v8, me p4, r4, v8; IV, fe p2, d3, r1, pa p4, r1, ti p3, d2, r3, v7, me p3, r3, v9; palp, fe p1, d4, pa 0, ti p3, ta 6 apical. Trichobothria on legs I-IV (palp): tarsi 7-8 (6) in a zig-zag row, metatarsi 7-10 in one straight row, tibiae 5-7 (6) in two proximally divergent rows.

Paired claws with teeth in two rows of 4-7; unpaired bare.

Palpal cymbium spinose, with two rounded lobes. Bulb pyriform; embolus long, thin, with spiral tip (Fig. 7D-F).

PMS absent; PLS 1.6 long; apical segment digitiform, 0.5, median 0.4, basal 0.5 long.

Paratype female QMS6208: Total length, including chelicera 6.6. Carapace 2.3 long, 1.9 wide. Abdomen 3.1 long, 1.9 wide. As for ♂ except:

Body generally pale brown, chelicera slightly darker. Abdominal pattern less evident.

Caput more distinctly raised than in ♂ (Fig. 7C). Fovea straight, 0.3 wide, occupies ca. 1/5 of carapace width at that point.

Eye group 0.27 long, front width 0.48, back width 0.48, occupies almost half of head width at that point. Sizes and interdistances: AME 0.08, ALE 0.14, PME 0.10, PLE 0.14; AME-AME

0.08, AME-ALE 0.02, PME-PME 0.16, PME-PLE 0.02, ALE-PLE 0.03.

Chelicerae weak, 0.6 long, no rastellum; furrow with 8 teeth on promargin and 7 tiny basomesal denticles. Maxillae quite narrow, 0.5 wide, front length 0.7, back length 1.0, with 8(9) cuspules at prolateral-proximal corner. Labium 0.2 long, 0.5 wide, no cuspules. Sternum 1.1 long, 1.1 wide.

Leg and palp measurements:

	I	II	III	IV	Palp
Femur	1.6	1.3	1.2	1.6	1.3
Patella	1.1	0.9	0.8	1.0	0.8
Tibia	1.1	0.9	0.8	1.2	0.8
Metatarsus	0.8	0.8	1.0	1.6	-
Tarsus	0.6	0.7	0.7	1.0	0.8
Total	5.2	4.6	4.5	6.4	3.7

Leg formula 4123. Tarsi aspinose. Scopula very light on tarsi of palp and leg I. Spines: I, fe d5 (long stout bristles); II, fe d3 (long stout bristles), me v6; III, fe d3 (long stout bristles), pa p2, r3, ti v7, p2, d4, me v7, p2, d5; IV, fe d3 (long stout bristles), pa p2, r3, ti v7, p2, r2, d1, me v7, p2, d5; palp, fe d2 (long stout bristles), ti v2, ta v2 + several short stout bristles. Trichobothria on legs I-IV (palp): tarsi 5-8 (6) in a zigzag row, metatarsi 6-8 in one straight row, tibiae 5-6 (5) in two proximally divergent rows. Paired claws with 2 rows of 4-6 cylindrical teeth, confined to basal half of claw on posterior legs; unpaired claw long, only slightly bent. Palpal claw with prolateral row of 4 teeth.

PMS absent. PLS 1.3 long; apical segment digitiform, 0.4, median 0.4, basal 0.5 long.

Spermathecae two, triangular, each divided into short pointed inner lobe and longer knob-shaped outer lobe bent forward.

VARIATION

Carapace lengths in ♂ 3.2-3.6, width 2.7-3.1 (n=4).

DISTRIBUTION & HABITAT

Known only from Doi Inthanon, Chiang Mai Province, Thailand at 2000-2300m altitude. Males were trapped in pitfalls and juveniles were found in leaf litter and under rotten wood on the forest floor. The young ♀ kept in captivity constructed no web or burrow.

Sinopesa guangxi sp. nov.
(Figs 1, 3C, 4B, D, 8A-E)

MATERIAL EXAMINED

HOLOTYPE: MCZ, ♂, Dragon Lake, Lulzhou Guangxi, China, Jan 1982. AP.

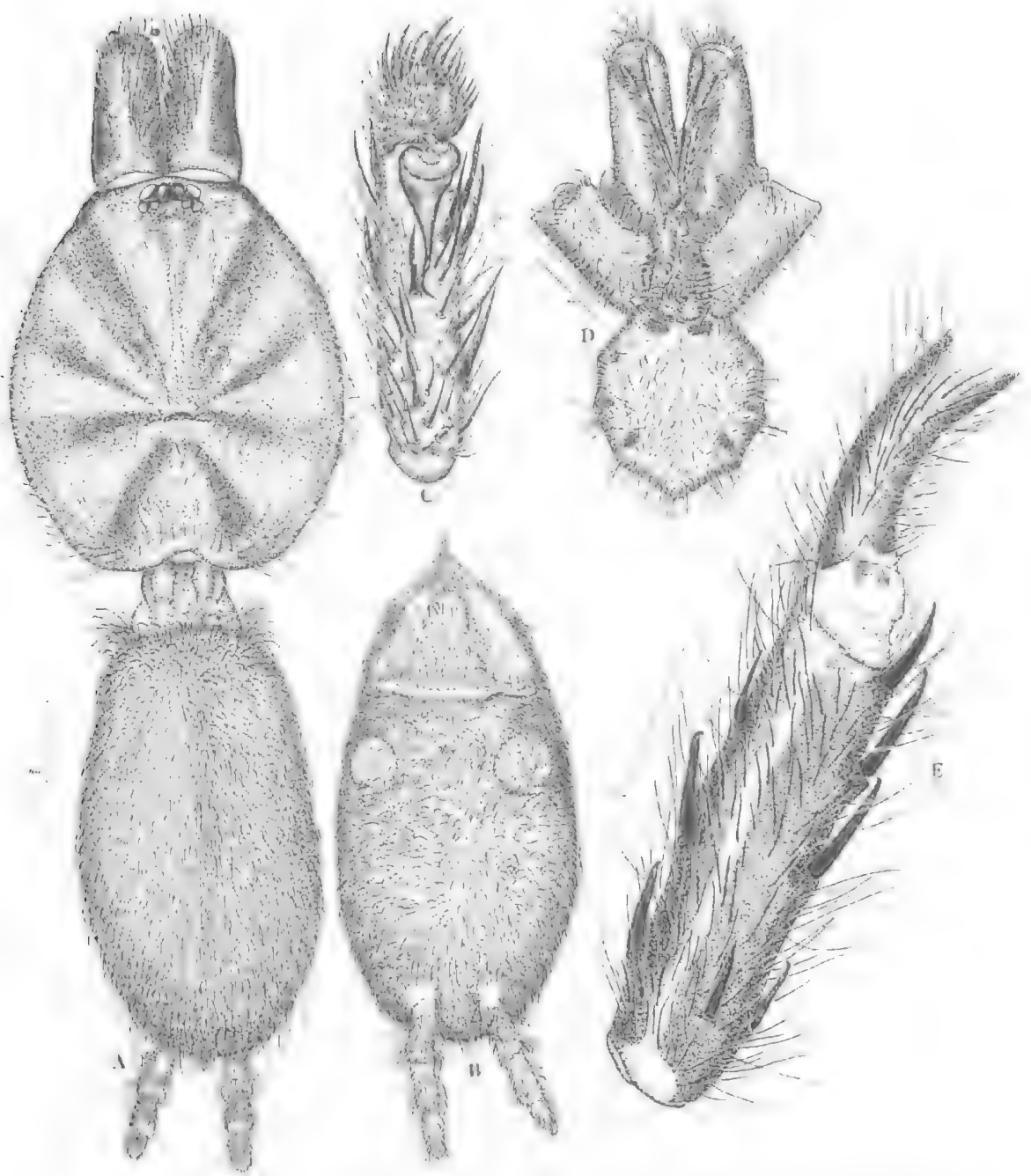


FIG. 8. A-E. *Sinopsea guangxi* sp. nov., holotype ♂. A, Carapace, chelicerae & abdomen, dorsal view. B, Abdomen, ventral view. C, Palpal tibia, tarsus & bulb, ventral view. D, Sternum, maxillae, labium & chelicerae, ventral view. E, Tibia & metatarsus I, proventral view.

ETYMOLOGY

For the type locality.

DIAGNOSIS

Larger than *S. maculata*; lacking abdominal pattern, posterior sigilla larger, and embolus tip only slightly corkscrew-shaped. ♀ unknown.

DESCRIPTION

Holotype male: Total length, 12. Carapace 5.31 long, 4.81 wide. Abdomen 5.13 long, 3.00 wide.

Carapace orange brown, legs orange to red-brown. Abdomen dorsally and ventrally pallid yellow-brown, no pattern (Fig. 8A).

Cephalic bristles short on caput and interstrial ridges; long on lateral margins; 4 long on clypeal edge; many anteromedially. Fovea short, shallow, slightly recurved (Fig. 8A). Clypeus absent. Caput elevation low, thorax sloping. Striae distinct.

Eye tubercle low, with almost sessile eyes save AME. Group occupies 2/5 of head-width. Two rows: front row 34, back row 85. Eye group front width, back width, length, 32:34:15. MOQ front width, back width, length, 14:22:13. AME:ALE:PME:PLE, 5:11:6:7. AME-AME, 0.6; AME-ALE, 0.3; PME-PLE, 0.2; PME-PME, 2; ALE-PLE, 0.2.

Chelicerae narrow, porrect, with long bristles. Rastellum absent. Fang smooth. Furrow promargin with 9 teeth, plus 1 small tooth, intermedially with 6-7 fine basally; several deep parallel ridges near intercheliceral tumescence area but not pallid; no teeth on outer margin of furrow.

Maxillae 1.30 long in front, 1.92 long behind, 0.84 wide; with c. 3-4 cuspules along edge. Heel produced over labium; anterior lobes just evident. Serrula absent. Labium 0.82 wide, 0.42 long. Labiosternal suture with 2 double, pallid, lateral areas, not grooved. Labium lacks cuspules; anterior edge indented. Sternum 2.28 long, 2.13 wide; distinct bristles along posterior edge. Sigilla all marginal, oval. Sigilla length, distance to margin: posterior 0.4, 0.16; middle 0.22, 0.16; anterior 0.19, 0.16. No prolateral coxal bristles; inner coxae not produced or angular.

Leg and palp measurements:

	I	II	III	IV	Palp
Femur	3.75	3.44	3.13	4.00	2.5
Patella	2.31	2.06	1.69	2.00	1.5
Tibia	2.94	2.62	2.38	3.50	1.78
Metatarsus	2.69	2.50	3.00	4.31	-
Tarsus	1.56	1.63	1.56	1.81	0.72
Total	13.25	12.25	11.75	15.63	6.50

Leg formula 4123. Setation light brown, adpressed. Tibia I darker and thicker than other

tibiae with ventral spines thicker and 3 on distal portion very raised, bases all movable. Metatarsus I curved for two-thirds of proximal length (Fig. 8E). No preening combs. No scopula on metatarsi; very thin and divided on tarsi I, absent on II-IV. Spines: I, fe p1, d3, r1, pa 0, ti p3, v5, me v1; II, fe p1, d2, pa p1, ti p3, v6, me v6; III, fe p3, d3, r2, pa p2, r1, ti p3, d2, r3, v7, me p6, r3, v7; IV, fe p1, d4, r1, pa p2, r1, ti p3, d3, r3, v6, me p6, r3, v7; palp, fe p1, d3, r1, pa p1, ti p3, r1, v6, ta 10 distally. Paired claws with 2 rows of teeth, 6-7 per row juxtaposed (I), longer on IV than II; on IV, teeth basal on outer face and distal on the inner face; unpaired claw on I hooked, bare, on IV longer, bare. Trichobothria in two rows, each of 11 on tibiae; full curving row of 10-15 on metatarsi; 15 in 2 bands for three quarters of length on tarsi.

Palpal bulb rugose, pyriform; embolus small with distally hooked tip. Tarsus short, with large spines similarly and deeply incised; no scopula. Tibia not incrassate; distal ventrally excavated (Fig. 8C).

PMS absent, without vestige. Length of basal, middle, apical, and total articles of PLS 0.75, 0.50, 0.63, 1.88, respectively; 0.55 apart. Apical segment digitiform. Australotheline crescent absent but sclerotised disc on ventral elastic cuticle between hirsute basal article and abdomen. Booklung apertures broad, ovoid (Fig. 8B).

DISTRIBUTION

Known only from Dragon Lake, Liuzhou, Guangxi, China.

Family DIPLURIDAE Simon, 1892

RELATIONSHIPS

As with the Cyrtacheiniidae, Goloboff (1993) found that the Dipluridae of Raven (1985) were paraphyletic. However, a possible new genus seen in the MNHN, Paris, is intermediate between Ischnothelinae and Euagrinae and may reduce that paraphyly significantly (Goloboff, pers. comm.).

Main (1993) also attempted to test the synapomorphies of the Dipluridae in establishing the relationships of the cave-dwelling genus *Troglodiplura* Main, 1969 and arrived at the same conclusion as Raven (1985).

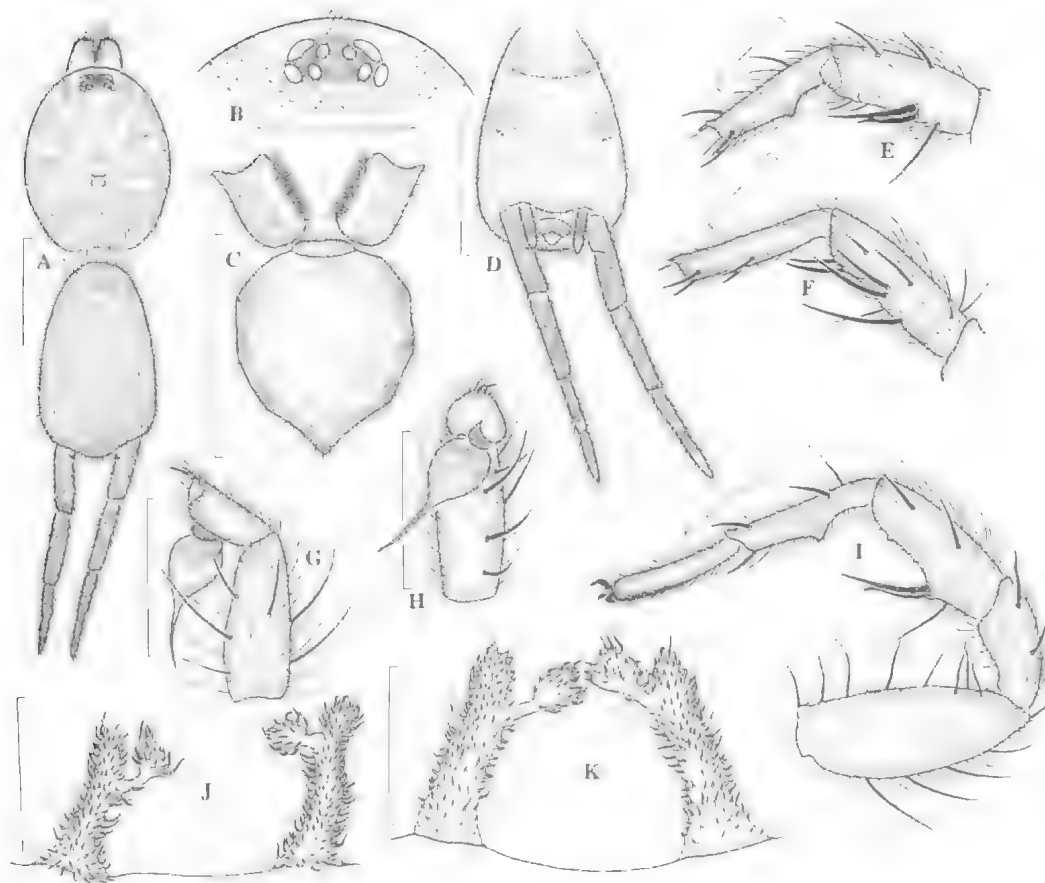


FIG. 9. A-K. *Leptothele bencha* sp. nov. A-H, K, ♂; I, J, ♀. A, body (without legs), ♂, dorsal view. B, eyes, dorsal view. C, maxillae, labium and sternum, ventral view. D, abdomen, ventral view. E, F, Tibia and metatarsus of leg II, retroventral view (E) and leg I, prolateral view (F). G, H, Palp, prolateral (G) and ventral (H) view. I, Leg II, prolateral view. J, K, Spermathecae of two ♀♀, dorsal view. Scale lines = 1mm, except B, E-I 0.5mm, J, K = 0.1 mm.

Subfamily EUAGRINAE Raven, 1985

Leptothele gen. nov.

TYPE SPECIES

Leptothele bencha sp. nov.

DIAGNOSIS

Leptothele is closely related to the genus group *Euagrus* Ausserer, 1875 plus *Phyxioschema* Simon, 1889 (Coyle, 1988), which share interlocking spinule patches on ♂ femora I and II, a median ♂ tibia II mating apophysis with megaspines and pseudosegmented apical articles of PLS. *Leptothele* resembles *Euagrus* Ausserer but differs in a single ventral process on

metatarsus II and a small transverse distal ridge on ventral tibia II of ♂ (Figs. 9E, I); the spermathecae lack sclerotised stalks, scopula light on tarsi I, II of ♂ and leg tarsi in both sexes aspinose. It also resembles *Masteria* in the small size and squat maxillae with glabrous tumid anterior edge but differs in dark pigmentation of the carapace, abdomen, and legs, in a narrow but band-like serrula (Fig. 5F) and in lacking an australotheline crescent.

DESCRIPTION

Tiny euagrine spiders with hirsute carapace and pit-like fovea (Fig. 9A). Eight eyes on tubercle. Chelicera geniculate, teeth only on promargin. Serrula a narrow band 3-5 denticles wide (Fig.

5F). Leg tarsi of both sexes aspinose; ♂ cymbium apically with cluster of thick dark, spine-like setae. No preening combs. Trichobothrial bases deeply corrugiform, as in *Masteria*; tarsal organ a low dome with concentric ridges (Fig. 4E); leg cuticle smooth. Paired claws with one row of teeth in slight S-shape; unpaired claw with several fine teeth, basally on a single process, distally sessile (Fig. 3E, F). Four spinnerets, PMS widely separated; PLS very long, with pseudosegmented apical joint; no australotheline crescent (Fig. 9D).

Males: tibia I unmodified but armed with thorn spines; tibia II with 2 megaspines on low spur medially and a small transversal ridge distally; metatarsus II bearing pointed ventromedian thorn (Fig. 9E, I); palpal bulb pyriform, with elongated embolus; cymbium dissimilarly lobed and apically with distinctly thick setae (Fig. 9G, H). Interlocking spinules on femora I, II.

Females with two spermathecae, densely covered by small protuberances. Each spermatheca divided in two lobes, the inner one with a narrow but not sclerotised stalk.

ETYMOLOGY

Greek, *leptos* (small, thin, weak) and *thele*, (wart, nipple = spinneret, in figurative sense). The gender is feminine.

RELATIONSHIPS

Absence of cuspules on maxillae and pseudosegmentation of ♂ tarsi indicate that affinities of *Leptothele* are clearly within the euagrine+masteriine clade (Raven, 1985, fig. 6). Presence of a spur and megaspines on tibia II and the associated absence of an australotheline crescent unequivocally places *Leptothele* in a trichotomy with *Euagrus* and *Phyxioschema*. However, dentition of the third claw severely tests the notion of the common process on the Masteriinae. At its basal end, the group of teeth resembles that of the Masteriinae—long teeth set on a broad base off the claw, whereas the base of the distal tooth is clearly on the claw (Fig. 3F). No doubt similar problems arise in determining the cheliceral dentition in plurident and fissident salticids.

Since Raven (1985), two new diplurid genera have been described. Of those, only *Chilehexops* Coyle, 1986 need be considered further. The trichobothrial bases of *Chilehexops* are unlike any other diplurids in that they lack the multiple longitudinal corrugations so well developed in *Masteria* (Raven, 1979; fig. 21). The segments of the posterior lateral spinnerets are more nemesoid in relative size—the apical segment is barely as

long if not shorter than the median segment. As Coyle (1986) noted, *Chile hexops* genus shows no close relationships with any known euagrine genus and may represent a separate clade within the Dipluridae where its inclusion requires another character change (spinneret relative length reversal) and a weakening homoplasy in the synapomorphies proposed by Raven (1985). In any case, it does not affect the position of *Leptothele* in the Dipluridae.

Leptothele bencha sp. nov.

(Figs 1, 2C, 3E, F, 4E, 5F, G, 9A-K)

MATERIAL EXAMINED

HOLOTYPE: QMS29275, ♂, Khao Phanom Benchan National Park, 8°15'N, 98°55'E, 260 m altitude, Krabi Province, Thailand, 21 Sep 1992, PJS. PARATYPES: QMS29276, MHNG, NHMW, 1 ♂ (matured 22 Oct 1992), 4 ♀♀, data as for holotype.

ETYMOLOGY

For the type locality.

DIAGNOSIS

As for genus.

DESCRIPTION

Holotype male: QMS29275. Total length 3.7. Carapace 1.49 long, 1.33 wide. Abdomen 1.74 long, 1.07 wide.

Carapace brown, mottled with dark brown on cephalic and coxal areas. Abdomen dorsally dark brown, apart from light anterior patch, densely covered with small grey hairs and few interspersed long setae in the anterior part. Legs and chelicerae light brown dorsally. Ventral side of body yellow brown. Spinnerets dark brown, with light ventral spots. In life, the spinnerets have a conspicuous white ventral side, like an icing, which is lost in alcohol.

Carapace oval, almost flat, highest near fovea, covered with fine brown hairs; setae absent. Fovea a deep pit, occupies ca. 1/10 of carapace width at that point (Fig. 9A).

Eyes on dark raised tubercle; two rows, front row slightly procurved, back row indistinctly recurved. Group 0.14 long, front row 0.31 wide, back row 0.34 wide, occupies slightly more than 1/3 of carapace width at that point. Sizes and interdistances: AME 0.06, ALE 0.10, PME 0.07, PLE 0.08; AME-AME 0.04, AME-ALE 0.01, PME-PME 0.11, PME-PLE 0.02, ALE-PLE 0.02.

Chelicerae small, 0.29 long, geniculate, with dorsal setae projecting anteriorly. No inter-

cheliceral tumescence. Fang groove with 11 teeth on promargin and with 6-7 tiny median denticles (granules). Maxillae 0.24 wide, 0.37 long in front, 0.40 behind. No cuspules or anterior lobe. Glabrous tumid area along proventral margin. Serrula a band 3-5 denticles wide (Fig. 5F). Labium 0.09 long, 0.30 wide. No cuspules. Anterior edge with setae and transverse glabrous tumid area. Sternum 0.88 long, 0.79 wide, cordate, covered with long setae. Sigilla indistinct, marginal. Labiosternal suture a broad groove.

Leg and palp measurements:

	I	II	III	IV	Palp
Femur	1.25	1.19	1.11	1.40	0.75
Patella	0.73	0.66	0.58	0.66	0.44
Tibia	0.92	0.84	0.78	1.13	0.52
Metatarsus	0.90	0.87	1.01	1.33	-
Tarsus	0.67	0.69	0.69	0.79	0.34
Total	4.47	4.25	4.17	5.31	2.05

Leg formula 4123. Legs covered with fine brown hairs and setae. Preening combs absent. Patch of spinules on retrodorsal femur I and prodorsal femur II form interlocking mechanisms. Ventral and prolateral tibia I with 9 long thick spines; coupling spur absent (Fig. 9F). Ventral tibia II with 2 megaspines on low median process (indistinct spur) and low transverse distal ridge. Ventral metatarsus II with short anteriorly inclined process like a cuticular thorn (Fig. 9E, K). Scopula weak on tarsi I, II. Spines: leg tarsi aspinose; I, fe d6 long, pa v4, ti p2, v7, me v4; II, fe d6 long, pa v4 (weak), ti p2, v1+2 megaspines, me p2, v2; III, fe d8 long, pa d5, r1, v3, ti d5, p2, r2, v6, me d4, p1(2), v6(7); IV, fe d8 long, pa d4, r1, v3, ti d5, p2, r3, v6, me d7, p2, r1, v5. Palp: fe d6 long, pa d3, ti d3, p2, v4, ta d2(3). Trichobothria discernible only with difficulty. About 5 in two rows on tibiae, 4-7 in one row on metatarsi and tarsi.

Paired claws with ca. 9 teeth in one sigmoid row; 3-5 needle-like teeth on unpaired claw and heel-like process below (Fig. 3E, F).

Palp. Cymbium dissimilarly lobed, retrolateral lobe more pointed and longest, bearing 2-3 short, terminal spines. Bulb pyriform, embolus long and tapering (Fig. 9G, H).

PMS 0.32 long, 0.08 wide, 0.32 apart; PLS 2.17 long, articles: basal 0.66, median 0.67, apical pseudosegmented 0.84 long, mid-diameter of basal article 0.18, of apical 0.09. Australotheline crescent absent (Fig. 9A, D).

Paratype female: QMS29276. Total length 4.8. Carapace 1.85 long, 1.46 wide. Abdomen 2.34 long, 1.63 wide. As for ♂ except:

Posterior portion of ventral abdomen darker than anterior.

Carapace hair cover more dense than in ♂; a pair of long bristles in front of fovea, one long sigmoid bristle in front of PME. Fovea occupies 1/12 of carapace width at that point.

Eyes group 0.20 long, front row 0.34 wide, back row 0.37 wide, occupies slightly more than 1/3 of carapace width at that point. Sizes and interdistances: AME 0.07, ALE 0.14, PME 0.08, PLE 0.10. AME-AME 0.04, AME-ALE 0.02, PME-PME 0.12, PME-PLP 0.02, ALE-PLP 0.02.

Chelicerae 0.38 long. Fang groove with 12 teeth on promargin and with 9-12 tiny median denticles (granules). Maxillae 0.38 wide, anterior length 0.50, posterior length 0.58. Labium 0.12 long, 0.40 wide. Sternum 0.99 long, 0.93 wide.

Leg and palp measurements:

	I	II	III	IV	Palp
Femur	1.27	1.22	1.16	1.42	0.91
Patella	0.76	0.73	0.67	0.76	0.55
Tibia	0.88	0.78	0.76	1.05	0.63
Metatarsus	0.84	0.79	0.91	1.17	-
Tarsus	0.56	0.56	0.64	0.64	0.69
Total	4.31	4.08	4.14	5.04	2.78

Leg formula 4132. No spinules on femora I, II. Scopula absent. Spines: leg tarsi aspinose; I, fe d6 long, pa v3 weak, ti p2, v4, me v3(4); II, fe d6 long, pa v4(5) weak, ti p3, v4, me p2, v4(5); III, fe d8 long, pa d4, r1, v3(4) weak, ti d3(4), p2, r2, v5(6), me d4, v5(7); IV, fe d9 long, pa d3, r1, v3 weak, ti d3, p2, r3, v5, me d4, p2, r1, v5. Palp: fe d5 long, ti v6, ta v6. Trichobothria discernible only with difficulty. About 6-7 in two rows on tibiae, 5-6 in one row on metatarsi and tarsi. Paired claws with 9-14 teeth in one sigmoid row, decreasing in size posteriorly; 13 (14) on palp, and ca. 5 needle-like teeth on unpaired claw.

PMS 0.43 long, 0.12 wide, 0.47 apart; PLS 2.22 long, articles: basal 0.69, median 0.69, apical, pseudosegmented, 0.84 long, mid-diameter of basal article 0.23, of apical 0.14.

Spermathecae two, each divided in two anterior lobes; inner lobe, knob-like, its stalk narrow, smooth and not sclerotised; all with dense cover of small pointed protuberances (Fig. 9I, J).

VARIATION

Body measurements (♂, n=2, ♀ n=4): total length (including chelicerae) 4.41-4.97, 4.8-6.1, carapace length 1.83-2.09, 1.9-2.0, carapace width 1.46-1.65, 1.4-1.6. One ♀ lacks one PMS, in another the fovea is short, straight, and transverse.

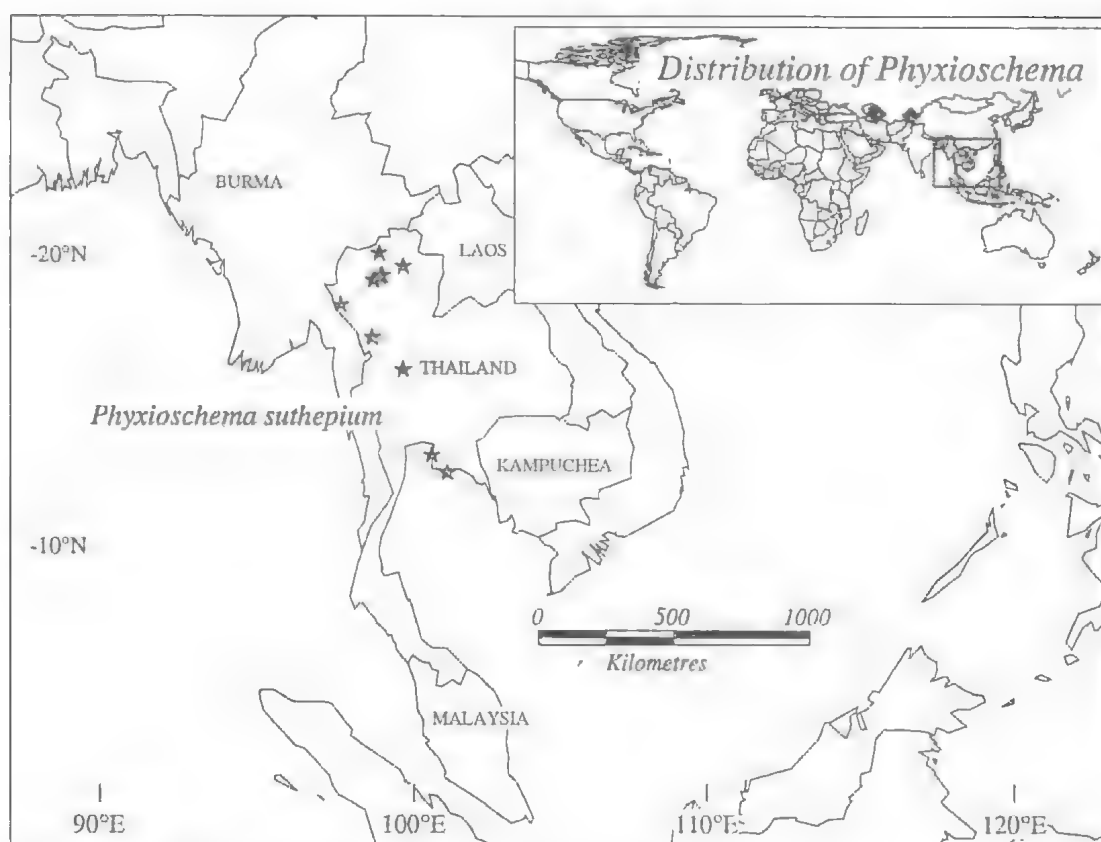


FIG. 10. Occurrence of *Phyxioschema suthepium* Raven & Schwendinger in Thailand; and of *Phyxioschema* (inset).

DISTRIBUTION & NATURAL HISTORY

Khao Phanom Bencha National Park, covering an isolated mountain near the west coast of southern Thailand. Spiders were found on slopes along a stream in semi-evergreen rainforest at altitudes of 250-280m. They live in small funnel-shaped webs, like those of *Phyxioschema suthepium*, under debris and in crevices on the forest floor.

One mature ♂ was taken from the forest in late September, another matured in captivity one month later. Females moult twice per year; moulting data: 25 Sep and 17 Jan (1st), 26 Nov and 16 Jan (2nd), 9 Oct (3rd), 18 Jan (4th), 20 Mar (5th ♀). One ♀ built its first lenticular egg case suspended in the web on 24 Sep (12 spiderlings hatched 6 Sep), its second in Oct (9 eggs) and its third on 12 Nov (5 spiderlings hatched 3 Jan); two other females had 16 and 13 eggs in their first egg case. Mating in captivity was not observed.

Phyxioschema Simon

Phyxioschema suthepium Raven & Schwendinger (Figs 10, 11A-F)

Phyxioschema suthepia Raven & Schwendinger, 1989, p. 55 (emended to *suthepium* by Platnick, 1993, p. 91.)

REMARKS

The diagnostic character "3 megaspines on ventral spur of ♂ tibia II", first given (Raven & Schwendinger, 1989) to distinguish *P. suthepium* from *P. raddei* Simon, is intraspecifically variable. Among 48 ♂ later re-examined, two had three megaspines on one side, and only one had three on both sides (Figs 11B-D); all others have only two megaspines (Fig. 11A). Three megaspines in *P. suthepium* males, thus is the rarer of two states. Other characters given in the description, however, sufficiently support *P. suthepium*.

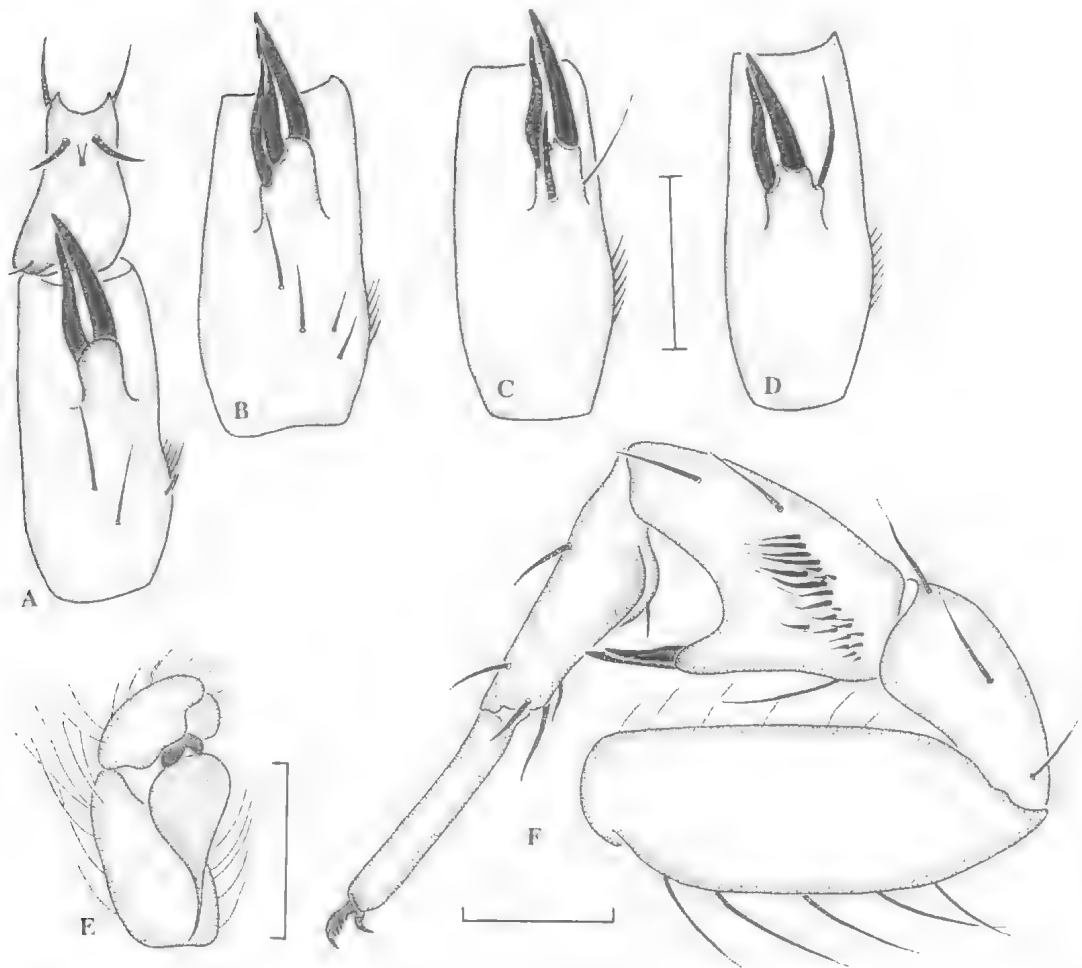


FIG 11. A-F. *Phyxioschema suthepium* Raven & Schwendinger. A, normal type of ♂ tibia and metatarsus II, ventral view. B-D, variation in number of megaspines on ♂ tibia II, ventral view. E, palp, retroventral view. F, leg II, prolateral view. Scale lines = 0.5 mm.

DIAGNOSIS (EMEND.)

P. suthepium differs from *P. raddei* in lacking foveal setae and having metatarsal preening combs on legs II-IV. Males with two rounded instead of three sharp ventral keels on proximal metatarsus II; 2-3 megaspines on tibia II.

DISTRIBUTION & NATURAL HISTORY

New records from the provinces Mae Hong Son, Nakhon Sawan, Choburi and Rayong indicate that *P. suthepium* occurs widely in lowlands (altitudes 30-750m) of northern, southeastern and central Thailand (Fig. 10).

One ♂, which matured on 19 Dec 1989, attempted a surplus moult on 5 May 1990. The exuvium was not completely shed, as the ster-

num detached from the coxae, and the spider died in the process. Supernumerary ecdysis in mature ♂♂ may be the result of exceptional longevity due to conditions in captivity.

ACKNOWLEDGEMENTS

PJS thanks Prof. Dr Panee Chiowanich and Dr Porntip Chantaramonkol (Biology Department, Chiang Mai University) for facilitating research in Thailand, which was supported by the Department of Technical and Economic Cooperation and by the Thai Ministry of University Affairs (Bangkok). The Royal Forest Department provided permission to collect specimens in protected areas, the National Research Council of

Thailand approved the research work. The "Österreichische Forschungsgemeinschaft" supported a visit by PJS to the Queensland Museum. Bronwyn Mitchell drew Figs 6A-C, E, 7A, D, L, M, and 8A-E. We are grateful to Dr Pablo Goloboff, Instituto "Miguel Lillo", Argentina, Prof. N.I. Platnick (AMNH), and Prof. F.A. Coyle, Western Carolina University, for comments on the manuscript.

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AN ALIEN FLATWORM IN AUSTRALIAN WATERS. *Memoirs of the Queensland Museum* 38 (2):642. 1995:- In the Botanical Gardens on Mount Coot-Tha, Brisbane are several ponds. One displays blue water lilies, *Nymphaea* spp., some of which are introduced. There, too, are small planarian flatworms (5) 5 cm long) with a triangular head with two white patches each containing a dark eye, and a yellowish brown body with numerous whitish spots.

Though this population appears exclusively asexual, external appearance is sufficient to identify *Girardia tigrina*, notorious for the ease with which it has recently extended its distributional range through accidental introductions. *G. tigrina* is a presumed native of North America; sexually reproducing animals found in Brazil and Uruguay are thought the result of human-aided immigration. In recent times *G. tigrina* has been introduced with aquarium plants into Europe (Dahm & Gourhault, 1978; Ribas et al., 1989) where it now occurs in natural water bodies. In Japan, this introduced species was initially found only in culture ponds and fish tanks, but a naturalised population has been recently reported from Nagasaki (Kawakatsu et al., 1993).

In Australia, unidentified, asexual specimens of *Girardia* sp. (possibly *G. tigrina*) have been reported from Victoria (Ball, 1974; Hay & Ball, 1979). Further indirect evidence for the occurrence of *G. tigrina* in Australia comes from a culture in Japan of Australian crayfish, *Cherax tenuimanus*, introduced from Western Australia in 1984. In 1985 an asexual population was present in the culture ponds (Tamura et al., 1985). It is probable that *Girardia* has already achieved quite a large distribution within Australia, most likely through introductions and unintentional transfer within the country.

Colonisation into new territories is facilitated by the species' capacity to readily reproduce by transverse fissioning; one animal can be the parent of an entire population. Several other planarian species have enlarged their distributional range as a result of human activities. The land planarian *Bipalium kewense*, originally confined to S.E. Asia, has been reported from hothouses worldwide, as it is easily transported in pots of soil with exotic plants. Another land planarian, *Arrioposthia triangulata*, was introduced from New Zealand into Britain, and was reported in 1963 from gardens near Belfast (Ball & Reynoldson, 1981). Presently, the species has spread over Northern Ireland and Scotland, and its predatory activities have caused serious depletion of local earthworm populations (Ogren, 1995; Putnam, 1994).

Other freshwater planarians have extended their ranges by human-aided dispersal. For example, *Phagocata woodworthi* was introduced into Loch Ness attached to North American equipment used during searches for the 'Loch Ness Monster' (Reynoldson et al., 1981). Introduction of *G. tigrina* into Australia could potentially threaten indigenous, but poorly studied, native planarians. *G. tigrina* feeds on small crustaceans, oligochaetes and gastropods by penetrating the body of its prey with its pharynx and sucking out the contents. In periods of lowered food supply they are able to shrink, calling on their body reserves. There are few known predators. Coupled with their powers of regeneration, this makes them formidably resistant. In continental Europe no ill effects of *G. tigrina* on the planarian fauna have been observed, but in Britain Reynoldson (1985) reported a rapid and drastic decline of two native planarian species after introduction of *G. tigrina* into an English coastal lake. According to Reynoldson, replacement of native planarians by *G. tigrina* probably results from interspecific competition for food. Australia has the greatest diversity and the most primitive representatives of the Dugesidae to which *G. tigrina* belongs. It would be tragic to have our indigenous fauna fall prey to American invaders.

Australia has a long history of planned and unplanned exotic introductions. Arthington & Mitchell (1986) high-

lighted the need for inspection and quarantine, with regard to disease, of introduced aquatic plants and fish. Small worms such as *G. tigrina* are not pathogens, but merely passengers of plants and will produce no obvious damage. Hence, they may be easily overlooked and easily transported either with plants or with water associated with plants and animals. They are small, generalist predators with evidently wide tolerances, and, because they can reproduce through fission as well as sexually, the worms can spread in a manner similar to many plants. This will be particularly enhanced through inadvertent human intervention. All three components of invasion reported by Arthington and Mitchell; introduction, establishment and dispersal, are easy for *G. tigrina*. Hopefully, the opportunity may exist to limit the spread of this alien, and monitor both its spread and impact on the native fauna as was advocated in Britain (Ball & Reynoldson, 1981).

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THE RESULTS OF TEST EXCAVATIONS IN THREE ROCKSHELTERS IN SOUTHWEST QUEENSLAND

RICHARD ROBINS

Robins, R. 1995 12 01: The results of test excavations in three rockshelters in southwest Queensland. *Memoirs of the Queensland Museum* 38(2): 643-666. Brisbane. ISSN 0079-8835.

In order to document the archaeology of southwest Queensland and to establish a chronology of Aboriginal occupation, test excavations were undertaken in three rockshelters to determine their suitability for further investigation and, if possible, to date the age of the deposits. All proved to have shallow deposits and the cultural component of each was sparse. The deposits from two were dated to the late Holocene. While occupation deposits from these types of sites can provide chronological evidence, it is likely to be limited to the late Holocene. Investigation of other types of sites, such as open sites or features associated with relict sediments, will be required to provide a chronology of Aboriginal occupation in southwest Queensland.

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Despite considerable knowledge gains over the last three decades, much of Australia remains archaeologically unknown. White and O'Connell (1982:3) observed that Sahul prehistory '... is based on appallingly small samples...' Not only are the samples small, they are also very biased in their distribution. While some areas of Australia have been subjected to considerable amounts of archaeological investigation which has enabled, amongst other things, the establishment of basic regional chronologies of Aboriginal occupation, other areas have received little or no attention. Southwest Queensland, where only one unpublished date has been obtained from a salvage excavation (P. Hiscock, pers. comm.) and only one brief report of a test excavation published (Hughes & Lampert, 1980), falls into the latter category. This paper builds on this small data base by presenting the results of test excavations undertaken in 1984 in three rockshelters in southwest Queensland. The work was undertaken as part of a larger baseline study designed to explore a range of aspects, including the dating of sites, relating to the archaeology of southwest Queensland (Robins, 1993).

A BRIEF HISTORY OF ARCHAEOLOGICAL WORK UNDERTAKEN IN SOUTHWEST QUEENSLAND

The early archaeological record for southwest Queensland is one characterised by infrequent articles, some in popular magazines and the occasional report in professional journals. Reports in the former category include that of Lewis's account of artefacts and campsites on the Cuttaburra and Kulkynne Creeks (Lewis, 1966);

those from the latter include those of Riddell (1928), who described a stone arrangement on Durham Downs, and Elkin (1949), who described the rock engravings on Nappermerrie Station and recounted their associated mythology.

In the late 1960's and early 1970's, Federal and State government-sponsored site recording programmes resulted in the recording of a number of sites throughout the southwest, the aims being to compile an inventory of sites and site types. A largely descriptive, non-theoretical approach was adopted. From these recordings, information about the nature and distribution of stone arrangements (Rowlands & Rowlands, 1976, 1978) and the style and content of rock engraving sites (Robins, 1977) was expanded. New site types were recorded, including burials, burial platforms, stone cairns, rockshelters with occupation deposits, scarred trees (as the result of obtaining wood for boomerangs and bark for canoes), possum trees, stone quarries, extensive artefact scatters, axe grinding grooves, clay and stone hearths and huts frames (Heritage Branch files, Queensland Department of Environment and Heritage; Robins, 1981; McKellar, 1984).

Oil and gas exploration in the Eromanga basin in the late 1970's, brought with it the need for Impact Assessments. This work, largely confined to the area around the Jackson oilfield between the Wilson River and Cooper Creek, resulted in a number of surveys being undertaken (e.g. Lance & Hughes, 1983; Lilley, 1983; Richardson, 1983; Hiscock, 1984a; Alfredson, 1987; Lance, 1990, 1992). In the course of these surveys large numbers of stone artefact scatters were recorded, and

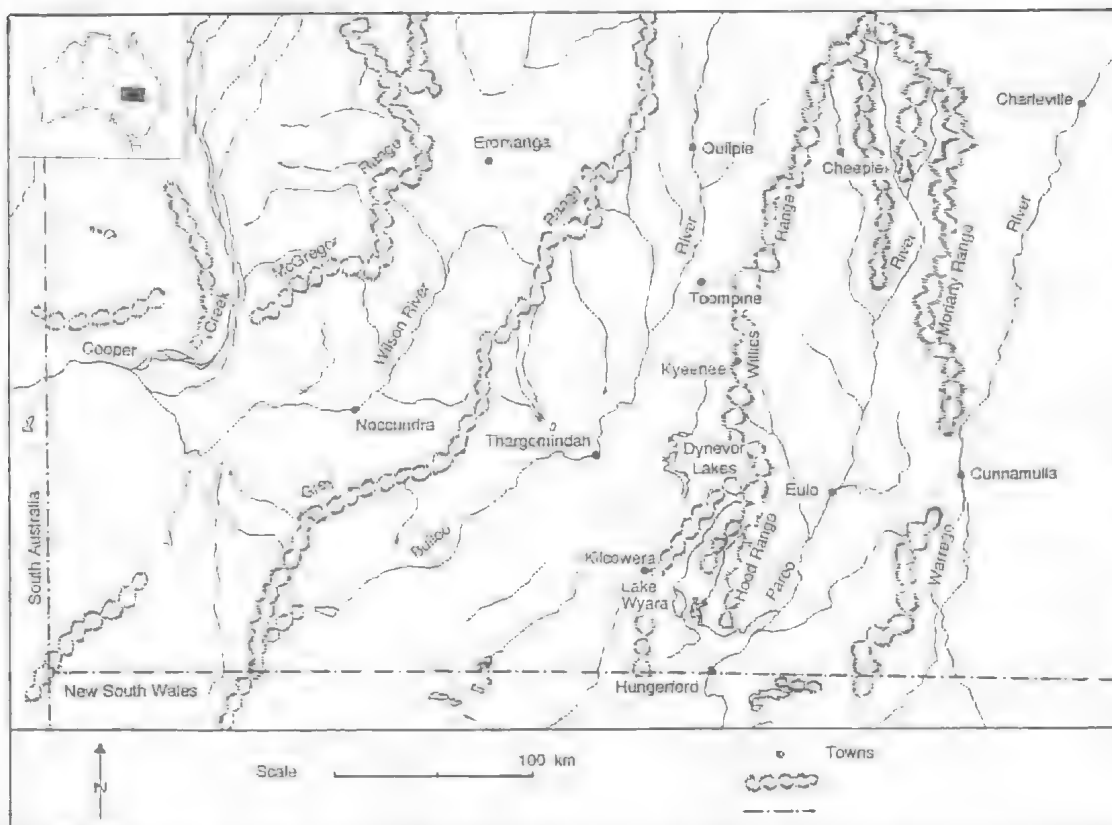


FIG. 1. Topographic map of southwest Queensland showing the location of Kilcowera and Kyeence Stations (after Dawson, 1974).

in some cases quarries, scarred trees and burials were also identified. Lance (1990) comments that most of these surveys were descriptive in nature, limited in scope and intensity, and were designed to identify sites to be avoided. The exception was a predictive base line study of the Nacowlah Block (Hiscock, 1985), in the vicinity of Cooper Creek and the Wilson River, where variations in the frequency and nature of sites were shown to depend on distances from water sources, raw material sources and proximity to land system boundaries.

Only two archaeological excavations have been undertaken in southwest Queensland. The first was by Hughes & Lampert (1980), who sank a 1 x 1 m test pit into the clayey core of a dune near Nappermerrie Station, on Cooper Creek. No artefacts were recovered from the core, although numerous artefacts were observed in a lag at the surface of the dune flanks. These artefacts were presumed to be Holocene in age, most of them younger than 5,000 years. Other artefacts were observed embedded in indurated sand above the

clay cores of dunes. From their geomorphic context, Hughes & Lampert deduced that they were late Pleistocene or early Holocene in age.

The second was a rescue excavation undertaken in 1983 where an oil pipeline intersected the lunette on the eastern side of Lake Toomarrow, on the Dynevor Lake system just east of Thargomindah. The excavator, Peter Hiscock, undertook the collection of part of a surface scatter of artefacts and carried out some test excavations. In one of the squares a date of 174 ± 50 yBP (Beta 7640) was obtained from charcoal at a depth of about 20 cm (P. Hiscock, pers. comm.).

This brief summary illustrates the poverty of archaeological information, particularly that relating to the temporal evidence of Aboriginal occupation, in southwest Queensland.

The situation in adjacent areas of New South Wales and South Australia is not greatly different. In northwestern New South Wales the most detailed work has been undertaken by Witter (1992), although some basic site recording work had been done previously (e.g. Stockton, 1977;

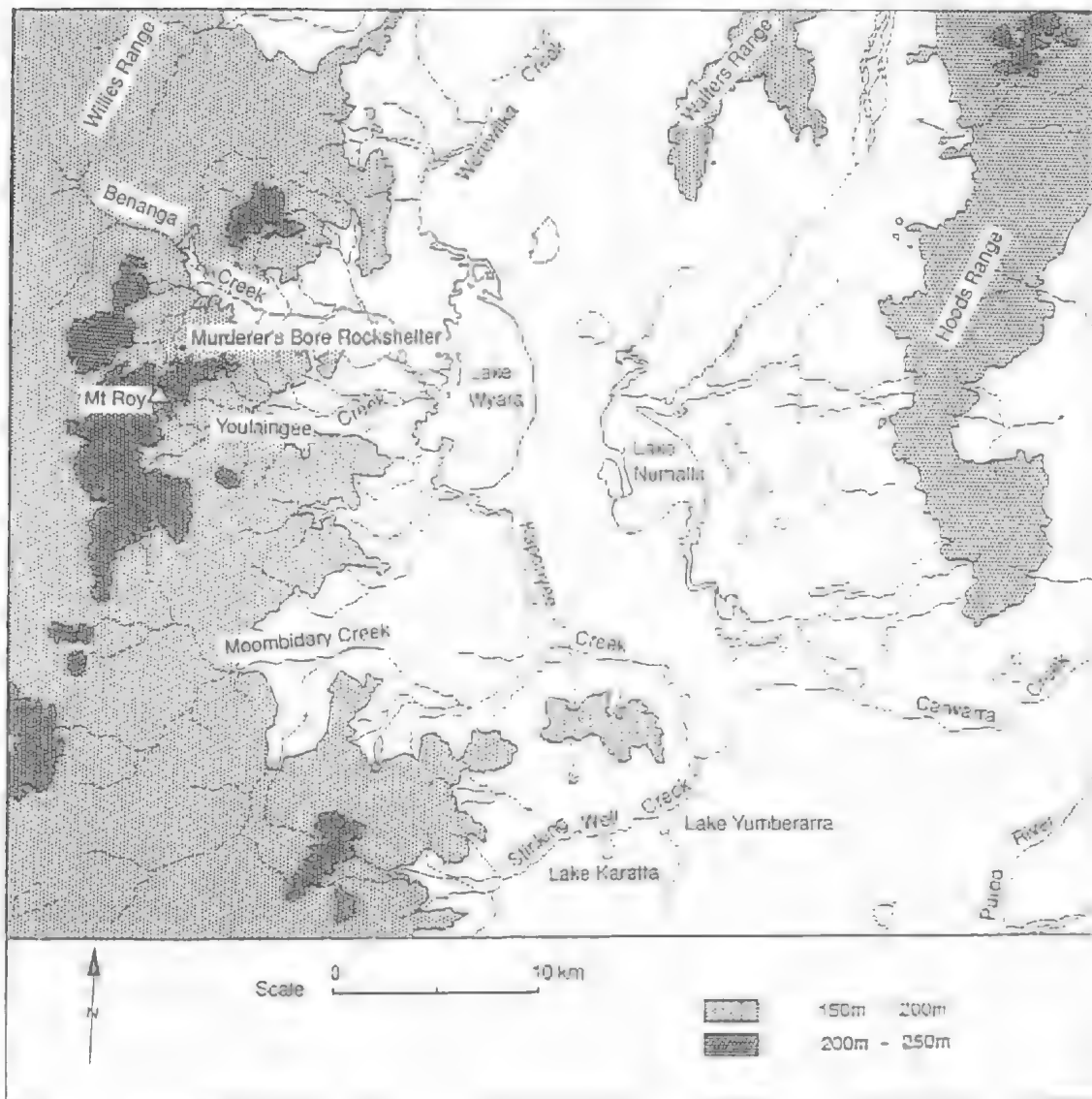


FIG. 2. Map showing the location of Murderer's Bore rockshelter.

Rowlands & Rowlands, 1976, 1978). Witter (1992) undertook a survey in the Tibooobarra area as part of a larger project designed to characterise stone artefact industries in three areas of New South Wales. During the survey, he recorded large numbers of artefacts differentially spread across the landscape. Although no excavation or dating was done, Witter assumed that the evidence is all mid-to-late Holocene in age on the basis of its general character and content, including the presence of artefact types that have elsewhere been dated to that time period.

Archaeological investigations along the Lower Cooper Creek in South Australia have determined that human occupation of that area extend back at least 12000yBP (Veth & Ham, 1989; Veth et al., 1990). A survey along the riverine corridor coupled with transects across the adjacent desert resulted in the recording of 204 archaeological sites. Distinct differences in site densities and assemblage structure between the eastern and western sections of the Lower Cooper Creek were interpreted as the product of differing Holocene settlement and subsistence strategies. The exca-



FIG. 3. Murderers Bore rockshelter.

vation of hearths buried within calcrete dune cores provided evidence of late Pleistocene (c. 12000yBP) occupation.

Survey work to the north around the Coongie Lakes by Williams (1988) recorded extensive mussel shell middens, termite mound heat retainers and stone artefacts. These sites were interpreted as late Holocene in age and reflect habitation near permanent or semi-permanent water. Excavations to the south of Cooper Creek, in the Strzelecki Desert, revealed evidence of late Pleistocene habitation. At the JSN site, charcoal

from hearths (Smith et al., 1991) produced dates ranging from about 14000yBP to about 2500yBP.

In summary, archaeological investigations in southwest Queensland over the last seventy years have resulted in a number of types of sites being recorded. However, it has really only been in the last two decades, and with the advent of oil exploration, that attempts at comprehensive archaeological recording have been carried out. This work has largely been descriptive in nature, and a temporal framework for the evidence is still lacking, although indications from nearby areas would suggest a history of occupation of consid-

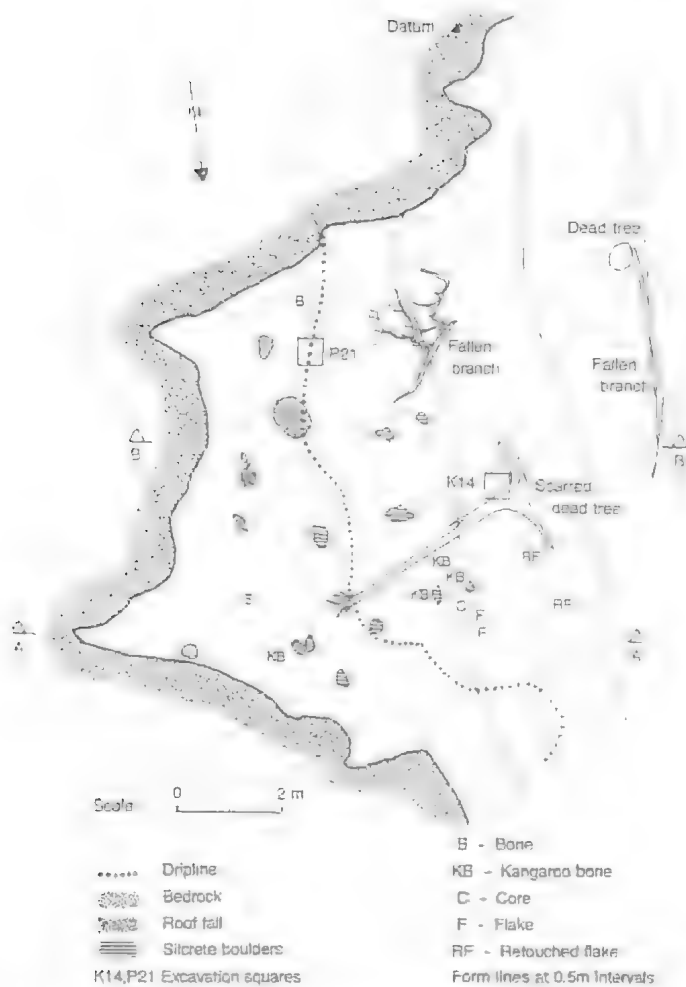


FIG. 4. Plan of Murderers Bore rockshelter.

erable antiquity. Important issues now for southwest Queensland archaeology are to obtain a chronology of occupation and to identify ways such a chronology might be obtained.

Elsewhere in Australia, archaeologists have traditionally focused on rock shelters and caves to obtain temporal information on human occupation. In southwest Queensland, numerous rockshelters occur in the sediments of the Winton Formation where they are exposed as dissected residuals, mesas and buttes. Most, however, occur in rugged terrain well away from permanent or semi-permanent sources of water, and most appear to contain only shallow and disturbed deposits which are likely to prove a poor source of archaeological information, particularly chronological information.

These assumptions, however, need to be addressed. Size or depth of rockshelters are not necessarily a good indicator of archaeological potential. A characteristic of Australian rockshelters is that old, or in other ways significant sites, do not have to be large or deep. A number of sites with deposits of about a metre in depth, such as Colless Creek (Hiscock, 1984b, 1990), Maidenwell (Morwood, 1986), Platypus Rockshelter (Hall et al., 1988), Bushrangers Cave (Hall, 1986), Fern Cave (David, 1991), and Birragai (Flood et al., 1987) have all provided dates that have made important contributions to archaeological knowledge at both a regional and continental level. Some test excavations of rockshelters in southwest Queensland were therefore necessary to establish the validity of the assumption concerning their archaeological potential. If the assumption was upheld, alternative approaches for obtaining chronological sequences in this area must be sought.

SITES

Three rockshelters were selected for investigation. The first, informally named Murderers Bore 1, is located on Kilcowera Station, which is located between the Paroo and Bulloo Rivers, approximately 60km NW of the Queensland/New South Wales border town of

Hungerford (Fig. 1). The rockshelter is located on the eastern side of the Willies Range, in the headwaters of Benanga Creek, which flows into Lake Wyara (Fig. 2). It was excavated during the 1984 field season as part of a preliminary survey of that area (Robins, 1993).

The remaining two rockshelters are located on Kyeene Station. Kyeene Station lies approximately 70km NW of Eulo and 80km NW of Thargomindah, midway between the Paroo and Bulloo Rivers (Fig. 1). It lies on a divide between Yowah Creek, which flows into the Paroo River 60km to the SE, and the tributaries of Bundilla Creek which flows into the Dynevor Lake system, 40km to the SW. One of these was a relatively large rockshelter recorded by the author in

TABLE 1. Summary of frequency, size and mass of artefacts types in excavations P21 and K14. Abbreviations: XU=Excavation Unit; ML=Mean length; MW = Mean width; MM = Mean mass.

XU	Artefact Type	No.	ML (mm)	MW (mm)	MT (mm)	MM (g)
P21/1	Flakes	2	30.1	27.7	7.9	12.5
P21/2	Flakes	3	10.6	11.4	2.9	0.3
K14/1	No artefacts					
K14/2	Flakes	9	11.2	10.3	3.2	0.8
	Flaked piece	4	8.4	4.2	2.2	0.4
K14/3	Tula	1	12.5	34.0	11.9	7.3
	Flake	1	9.0	12.0	1.4	0.2
	Flaked piece	1	4.1	7.3	1.7	0.1
K14/4	Flake	1	7.9	16.0	4.2	0.5

1977 (Queensland Department of Environment and Heritage Branch Site number EB:A16); the other was a smaller shelter. These rockshelters were informally Kyeene rockshelters I and II respectively.

MURDERERS BORE ROCKSHELTER

Murderers Bore rockshelter is located on the northwestern side of a finger of dissected residual that marks the boundary of the headwaters of the tributaries that flow into Benanga Creek. It is located 2.5km S of Murderers Bore, and 4km SW of Benanga Creek at its nearest point. Lake Wyara lies 13km to the east (Fig. 2). The closest point of the Paroo River is 40km to the southeast. The decision to excavate this site was based on the fact that of all the rockshelters in the study area it was the largest and appeared to have the deepest deposit. There were also obvious signs of human occupation in the form of stone artefacts on the floor, and a dead acacia tree at the entrance from which a section of wood had been removed.

The rockshelter is in a scarp retreat of a tableland and has a northwesterly aspect. The scarp consists of a thin capping of Glendower Formation silcrete covering the softer sandstones, siltstones and mudstones of the Winton formation (Fig. 3). The rockshelter has formed through the action of cavernous weathering on the softer sediments of the Winton Formation. The scarp retreat itself is highly eroded and is no more than 5m high in the vicinity of the rockshelter. The scarp abuts a talus slope with shallow red earths and silcrete, mudstone and siltstone boulders and gravel. The surrounding vegetation is predominantly bastard mulga (*Acacia clivicola*) and mulga (*Acacia aneura*) low open shrubland with

forbs and short grasses (Dawson, 1974). Waterholes in Benanga Creek would provide the nearest source of semi-permanent water. Youlain Springs, 7km to the southeast, would probably have been the nearest source of permanent water.

The rockshelter itself is small and has an irregular shape. Its mouth is approximately 10m long and 4m deep at its deepest point (Fig. 4). Maximum ceiling height is 3m (Fig. 5). Much of the surface of the deposit appeared scuffed by cattle, rock wallabies and kangaroos. The desiccated carcass of a kangaroo lay beneath a mulga tree at the entrance to the shelter. Bedrock was outcropping throughout much of the floor and boulders of roof spall and silcrete lay on the floor.

EXCAVATION PROCEDURE

After driving a nail into the bedrock to the north of the shelter to act as a datum, a baseline and an alpha-numeric 50cm horizontal grid was established for the site. The site was then mapped using 90° offsets from the baseline. Heights were determined with an autotest level. Two 50cm squares (K14 and P21) thought to have the greatest depth and the least amount of disturbance were selected for excavation. P21 was selected because it was the highest point in the deposit. K14 was selected in the hope that sediments eroding downslope



FIG. 5. Topographic profiles across Murderers Bore rockshelter.

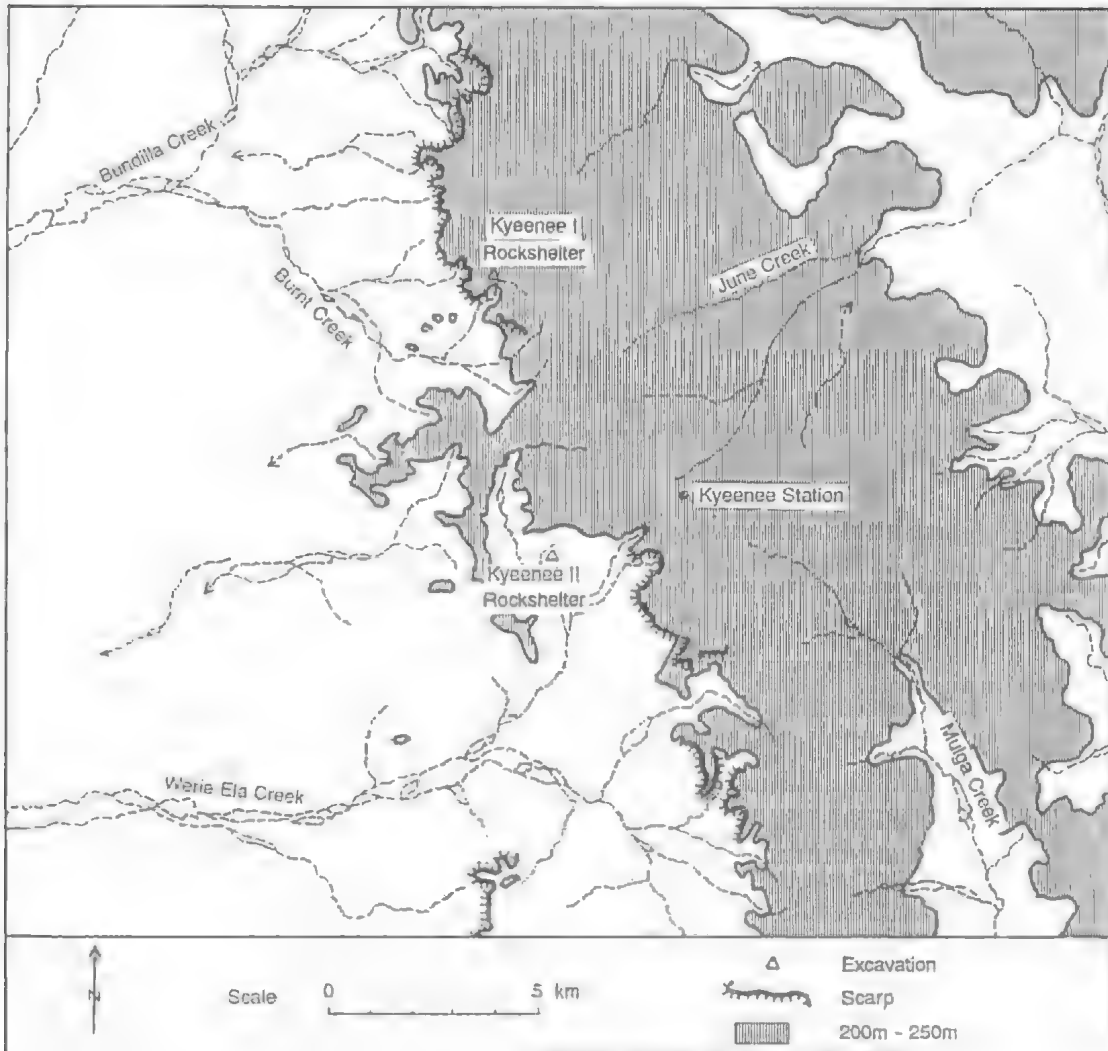


FIG. 6. Location of Kyeenee I and Kyeenee II rockshelters.

would be trapped by the roots of the *Acacia* at the entrance. Excavation followed the procedures and proforma outlined by Johnson (1979:145-165). Excavated material was sieved through 2mm and 4mm wire mesh. Soil colours were obtained using a Munsell Soil Colour Chart (Munsell Colour Co, 1990).

All the material held in the sieves was retained for laboratory sorting. For each excavation unit (XU), a grab sample (approximately 100g) of the material that had passed through both sieves was also retained for further analysis.

A 10 x 10m square extending from the baseline down the talus slope was laid out. In addition to basic environment data, the minimum and average artefact densities, raw material types, artefact types, the minimum and maximum size of flakes, cores and grindstones morphologies were recorded (Robins 1993: 364-368; glossary).

DEPOSIT DESCRIPTION

P21 was excavated in two XUS. It contained 21.75kg of deposit and had a depth of 6cm. The top 1-2cm was a dry, coarse reddish-yellow (Munsell (7.5YR 6/6)) sandy deposit with some



FIG. 7. Kyeene I rockshelter.

gravel and well rounded pebbles. Beneath this surface layer is a dry, compact, strongly brown layer (7.5YR 5/6) with increasing amounts of decaying bedrock to the base. The deposit has been disturbed by a tree root growing through it. Small amounts of charcoal occurred throughout.

K14 was excavated in five XUs. It contained 41.75kg of deposit and had a maximum depth of 40cm. The top 1-2cm is similar in texture to that encountered in P21; a dry, coarse, sand with gravel and cobbles, presumably derived from the sandstone bedrock. Beneath this surface layer the deposit is finer and more friable, but contains the

same amount of coarse material. The colour of the deposit, reddish brown (5YR 4/4), remains the same throughout. In parts of the square, bedrock was encountered within 2cm of the surface while in other parts of the square the deposit was up to 40cm in depth, indicating a very uneven bedrock base. The deposit contains tree roots and wood, leaves and small amounts of charcoal. A radio-carbon date of 450 ± 70 yBP (Beta 11593) was obtained from charcoal in the basal unit.

LABORATORY PROCEDURE

The retained sieve fractions were sorted for cultural material, bone, charcoal and organic material. Munsell Soil Colours were taken on the



FIG. 8. Plan of Kyeence I rockshelter.

air-dried fine fraction. All the sorted 2mm and 4mm sieved material was retained, bagged separately and registered Queensland Museum QMS829.

All identified artefacts were weighed and measured for length, width and thickness. Attempts were made to identify retrieved bone to species or genera level and the bone was examined for evidence of burning.

CULTURAL MATERIAL

Twenty five stone artefacts were recovered from both pits; 5 from P21 and 20 from K14. All the artefacts recovered from P21 were flakes while K14 contained 14 flakes, 5 flaked pieces and 1 tula (Table 1). Sixty five percent of the artefacts recovered from K14 were from XU 2.

The small number of artefacts from these pits restricts detailed analysis. All the artefacts recorded are silcrete. Flake lengths range from 3-49mm. In general, there is not much difference between average flake length and width in either pit (Table 1). In K14 mean length was 9.4mm and the mean width 11.2mm. In P21 mean length was 18.4mm and mean width 17.9mm.

Two small fragments of unidentifiable mammal bone were found in XU 1 of K14 which could be the result of natural death or introduction by humans into the site.

A dead tree (probably *Acacia aneura*) at the front of the shelter retained a scar where a section of wood had been removed from the trunk. This scar was 850mm long and 250mm wide at its widest point.

ASSOCIATED ARCHAEOLOGICAL EVIDENCE

In the 10m square laid out from the baseline down the talus slope, 166 artefacts were recorded from the surface, including 141 flakes, 14 re-touched flakes, 6 cores, 2 multi-platform cores, 2 tula slugs and 1 tula. Maximum flake length was 70mm and minimum 1mm. Maximum length of cores was 220mm and minimum 30mm. Sixty percent of flakes were between 60-100mm long. Fifty percent of cores were less than 100mm long.

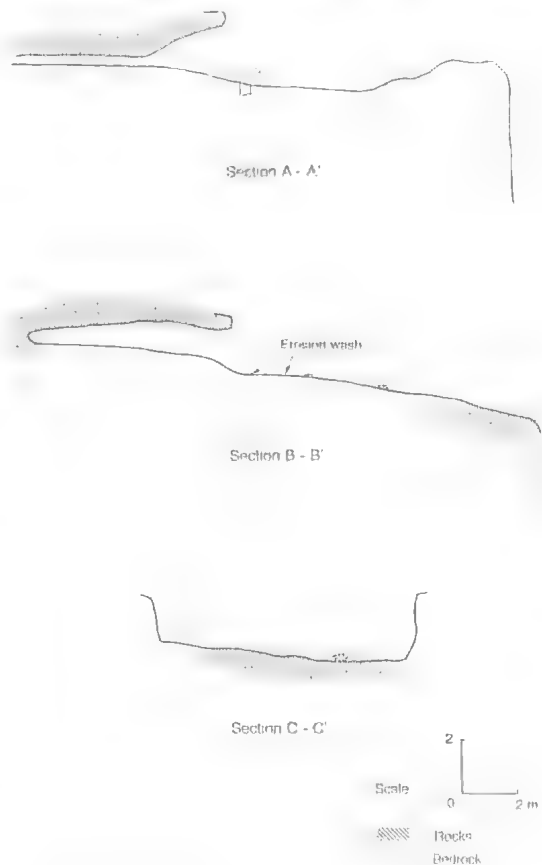
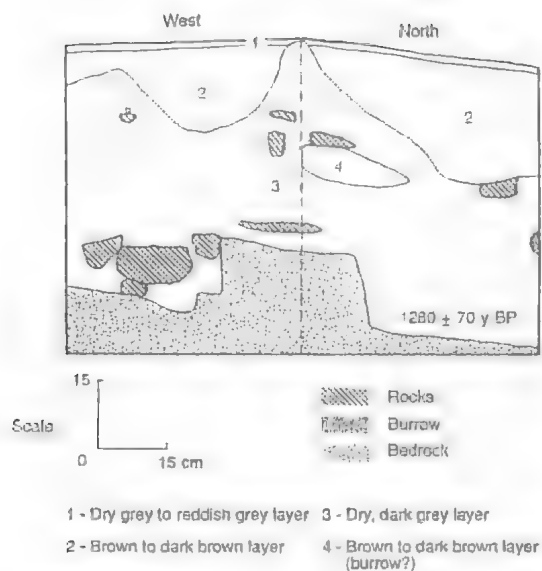
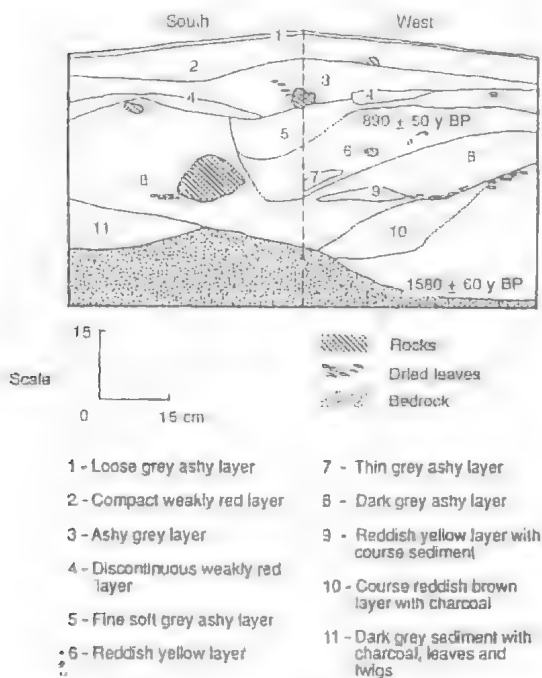


FIG. 9. Topographic profiles across Kyeence I rockshelter.



Excavation pit J9



Excavation pit J12

FIG. 10. Cross-sections of two faces in excavations J9 and J12, Kyeenec I rockshelter.

TABLE 2. Carbon content, colour and soil reaction for selected in excavation J12, Kyeenec I rockshelter. Abbreviations: XU=Excavation unit SR= Soil Reaction

XU	% Carbon (Av.)	Munsell Colours		SR (pH)
		Wet	Dry	
J12/1	18.5	7.5 YR 3/2 dark brown	7.5 YR 3/4 dark brown	6.4
J12/7	16.5	7.5 YR 3/2 dark brown	7.5 YR 4/2 brown to dark	6.4
J12/13	12.0	7.5 YR 3/2 dark brown	7.5 YR 4/3 dark brown	4.4

while 30% were between 160mm-300mm long. This figures illustrate the relatively small nature of the artefacts. It is probable that the cores were obtained from the locally available silcrete in gibber form.

Distribution of artefacts across the surface was patchy with artefact densities ranging from between 0-15/m². Mean artefact density was between 1 and 5/m². No knapping floors were observed.

SUMMARY

This rockshelter contained a shallow cultural deposit of recent age. There was evidence of disturbance and it is possible that much of the deposit had been moved downslope from the shelter. The shelter had a low density of cultural material in the form of stone artefacts. Charcoal, faunal and floral remains were also found in the deposit but their presence may be attributed to either human or non-human causes. The small number and limited range of types represented by the artefacts both in the deposit and on the slope reinforce that the impression that site use was infrequent and involved a limited number of activities.

KYEENEC I ROCKSHELTER

Kyeenec I rockshelter is located in an escarpment at the headwaters of Burnt Creek, 6.5km northwest of Kyeenec homestead. Burnt Creek flows into Bundilla Creek 7km to the northwest (Fig. 6). The rockshelter has formed at the head of a steep-sided gully system fingering into a scarp of Winton Formation dissected residuals. The surface of the plateau has very shallow reddish brown to red, acid, loamy lithosols mixed with boulders and gibber of silcrete and the Winton Formation deposits. The vegetation consists of areas of rockgrass (*Eriachne mucronata*),

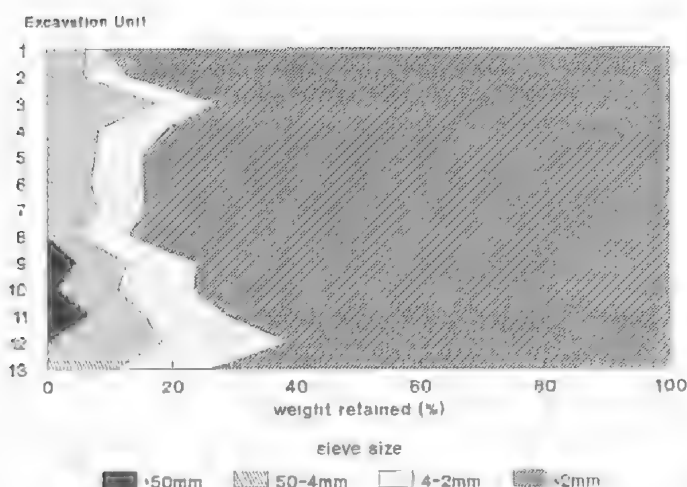


FIG. 11. Gross texture of XU sieved in the field, excavation J12, Kyeenee I Rockshelter.

mulga (*Acacia aneura*), western bloodwood (*Eucalyptus terminalis*) open tussock grassland, and mulga, lancewood (*Acacia petraea*), bastard mulga (*Acacia clivicola*) tall open shrubland (Dawson, 1974). Within the gully system, large river red gum trees (*Eucalyptus camaldulensis*) grow. Semi-permanent water can be found in a series of waterholes along the gully floor. The rockshelter is located at the head of a small, sloping bench which is above, and to the southern side of, the termination of the main gully system (Fig. 7). It has a north-easterly aspect. The escarpment plateau is within 1-1.5m of the rockshelter vault. Bedrock walls extend out from the rockshelter to box in the bench on its western and eastern sides to a maximum 6m width. A dropoff to a small semi-permanent waterhole restricts its length from the rockshelter overhang, to 10m (Figs 8,9).

The entrance to the rockshelter is approximately 8m wide and 2m high. Eight metres in from the entrance the rockshelter divides into two chambers that both extend back approximately 4m, giving a total depth of 12m. Within 4m of the entrance the rockshelter height is about 1m (Fig. 9).

A shallow depression in the bedrock above the shelter collects surface water and directs it over the lip of the shelter, onto the bench and then into the rock pool below. This runoff has resulted in erosion and compaction of parts of the deposit on the bench (Fig. 8).

The shelter is host to a colony of bats and the surface of the deposit is covered with bat dung. The desiccated carcasses of two wallabies, sheep fleece and some bones of a sheep were also in the shelter. Wallaby and kangaroo dung was also evident in the deposit. Parts of the surface of the deposit, particularly towards the rear, appeared to have been extensively scuffed by animals. Charcoal and two artefacts were noted in the deposit prior to excavation.

EXCAVATION PROCEDURES

A nail hammered into the southern bedrock wall was used to define datum. A levelled baseline was then run at 355° across the bench. From this line a series of 90° offsets were run to various points in

the site to outline its shape and to define an alpha-numeric grid. An autotest level was used to obtain heights at various points on the bench. Where use of the level proved difficult, particularly in the cave, a water level substituted. Two profiles were run the length of the shelter and bench.

TABLE 3. Faunal remains in excavation J12, Kyeenee I Rockshelter. Abbreviation: XU=Excavation Unit

XU	Mass (g)	Identification
J12/3	0.89	Unidentifiable
J12/4	0.47	Snake vertebrae (python) Mammal vertebrae (rat size) Petrogale occipital (Possum)
J12/5	0.76	Rodent dentary fragment Small Rodent size fragment Snake cranial fragment Fragment, small rat size vertebrae
J12/6	8.49	Snake vertebrae, rodent incisor, size scapula fragment, macropod scapula (<i>M. rufus</i> size)
J12/8	5.25	Rodent incisor, rodent maxillary fragment, possum size humeral fragment, macropod dentary fragment (<i>M. rufus</i> size), unidentifiable fragment
J12/9	0.98	Maxillary fragment (large macropod), snake vertebral fragment, small bird vertebral fragment
J12/1	10.29	Rodent incisor, dentary fragment of <i>Perameles</i> sp. (bandicoot), mammal fragments Dentary fragment
J12/1	20.1	Unidentifiable

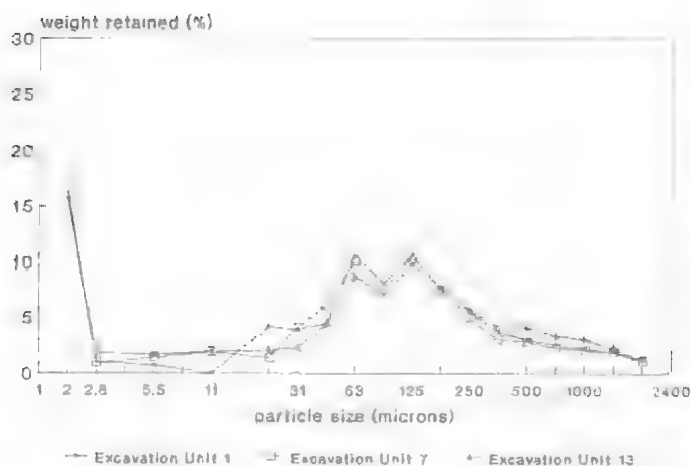


FIG. 12. Particle-size distribution in the <2mm field sieved fractions from XU 1, 7 and 13, excavation J12, Kyeenec I rockshelter.

One 50cm square, J12, was laid out just inside the mouth of the rockshelter and another, J9, was laid just outside the dripline. The squares were positioned in areas thought to have a combination of the greatest depth of deposit with the least amount of disturbance. The squares were then excavated following the procedures outlined by Johnson (1979:145-165). The excavated material was sieved through 2mm and 4mm wire mesh and weighed using a spring balance. All the material held in the sieves was retained for laboratory sorting. A grab sample of approximately 100g of the <2mm residue was retained from each excavation unit for further analysis.

LABORATORY PROCEDURES

The 4mm sieved fraction was sorted into its constituent parts: stone, stone artefacts, charcoal, bone and organic material. The 2mm sieve fraction was wet sieved before sorting into the same categories. After analysis, the sorted material was bagged according to category, and registered into the collections of the Queensland Museum under the registration number QMS828.

All identified artefacts were weighed and measurements of length, width and thickness taken. Recovered bone was sorted into individual fragments and identified to family or genus where possible. Organic fragments were sorted and attempts to identify individual fragments to genus or species were made.

Soil analysis of the fine fraction was undertaken on selected Excavation Units (J9/1/8/16 and J12/1/7/13). This included particle-size anal-

ysis, organic carbon content, wet and dry Munsell soil colours and soil reaction (pH).

DEPOSIT DESCRIPTION

The character of the deposit inside the shelter is different to that outside the shelter. The deposit inside the shelter exhibited a light, dry, complex character while the deposit outside the shelter is more compact and homogeneous.

J12 PROFILE DESCRIPTION

J12 contained deposit to a depth of 55cm. Eleven stratigraphic units (SU) were identified in the southern and eastern profiles of the test pit (Fig.10).

SU 1 is a thin, even surface layer approximately 2cm thick. It is a grey (5Y 6/1), loose, disturbed deposit with a large amount of bat and macropod dung mixed with some roof spall.

SU 2 is a weak red (10YR 5/3) layer between 5cm and 8cm thick. It contains kangaroo and bat dung, leaves and twigs and charcoal. This is a more compact, less disturbed layer than SU 1.

SU 3 is an uneven, grey (5YR 6/1), ash rich layer varying in thickness between 2cm and 10cm. This layer still contains bat dung, leaves

TABLE 4. Organic Remains recovered from excavation J12, Kyeenec I Rockshelter. Abbreviation: XU=Excavation Unit

XU	Mass (g)	Identification
J12/4	28.5	<i>Eucalyptus</i> sp. (leaves, fruit) <i>Acacia</i> sp. (phyllodes)
J12/5	24.9	<i>Eucalyptus</i> sp. (leaves) <i>Acacia</i> sp. (phyllodes)
J12/6	21.8	<i>Eucalyptus</i> sp. (leaves) <i>Acacia</i> sp. (phyllodes) <i>Abutilon</i> sp. (fruit)
J12/7	15.6	<i>Eucalyptus</i> sp. (leaves, fruit) <i>Acacia</i> sp. (leaves)
J12/8	3.9	<i>Eucalyptus</i> sp. (fruit) <i>Acacia</i> sp. (phyllodes)
J12/9	9.6	<i>Eucalyptus</i> sp. (leaves) <i>Acacia</i> sp. (phyllodes)
J12/10	12.4	<i>Eucalyptus</i> sp. (leaves) <i>Acacia</i> sp. (phyllodes)
J12/11	4.5	<i>Eucalyptus</i> sp. possibly <i>tessellaris</i> (leaves) <i>Acacia</i> sp. (phyllodes)
J12/13	.8	<i>Eucalyptus</i> sp. (leaves) <i>Acacia</i> sp. (phyllodes)



FIG. 13. Wood shavings, XU 5, J12.

and twigs but increasing amounts of both charcoal and roof spall were noted.

SU 4 is a thin, discontinuous, finely textured weakly red (10YR 5/4) deposit overlying SU 5 and 8.

SU 5 is a fine, very soft, grey (5Y 6/1) ash rich layer with increasing amounts of roof spall and large charcoal fragments. This layer has a thickness of between 1cm and 9cm and is restricted to the southern side of the pit. It dips sharply at the southeast corner suggesting that it had been dug into SU 6.

SU 6 is a finer textured reddish yellow (5YR 6/6-6/8) layer with less charcoal than SU 5. It varies in thickness from between 6cm and 13cm. Like SU 5 above, it also dips sharply at the southeast corner, suggesting that it has been dug into SU 8.

SU 7 is a thin, discontinuous, grey (5 YR 6/1), ashy layer that intrudes into SU 6.

SU 8 is a thick, dark grey (5 YR 4/1), ash rich layer with large amounts of charcoal as well as leaves and twigs. It has uneven upper and lower boundaries.

SU 4, 5 and 6 directly overlie SU 8 which in turn lies on Stratigraphic Units 10 and 11 as well as bedrock. It varies in thickness from between 5cm and 25cm.

SU 9 is a small yellowish red (5YR 5/6) lens of coarse sediment within Unit 8.

SU 10 is a reddish brown (5YR 4/4) lens containing coarse sediments and charcoal. It lies both on bedrock and SU 11 and has a maximum thickness of 10cm.

SU 11 is a discontinuous unit lying on bedrock. It is absent in the southeast corner of the pit, suggesting that SU 8 has been excavated into SU 11. It is a fine, dark grey (5YR 4/1) sediment with charcoal, leaves and twigs throughout.

The profile reveals a complex depositional history. Stratigraphic Units 11, 8, 6, 5, 3, and 2 represent a series of occupation events indicated by large amounts of charcoal and roof fall as well as disturbance of previous deposits. The occupation represented by these events alternates with discontinuous SUs 10, 9, 7, 4, which contain less charcoal and finer sediments. These may represent substantial breaks between episodes in the rockshelters' use or, alternatively, disturbance of the deposit. However, quantification of deposition rate to investigate rockshelter use is difficult on the basis of this small pit.

J12 SEDIMENT ANALYSIS

J12 was excavated in 13 Excavation Units and produced 110kg of sediment. Laboratory analysis

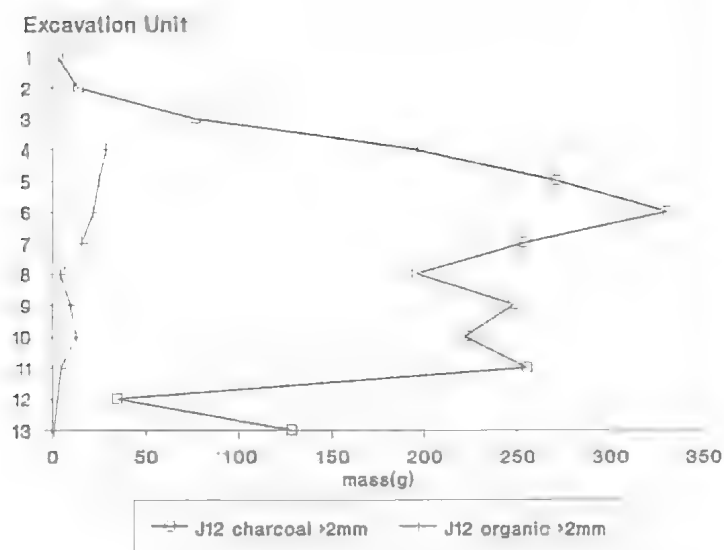


FIG. 14. Charcoal and organic remains from excavation J12, Kyeenee I rockshelter

of the excavated sediments indicated that although the profile is complex, the similarities between stratigraphic units as measured by particle-size analysis, percentage carbon, wet and dry Munsell colours and soil reaction, are greater than the differences.

Only three Excavation Units; 9, 10, and 11, contained stones >50mm in diameter. Throughout the deposit the proportions of the sieved fractions remained relatively constant. The percentage retained in the 4mm sieve for each excavation unit varied between 5% and 17%, in the 2mm sieve between 20% and 3%, while the <2mm fraction varied between 61% and 90%. The greatest variation in percentages occurs near the base of the pit where weathered bedrock makes a greater contribution of coarse material, in XU 3 and at the surface where the proportions of finer sediments are greater (Fig.11).

A half-phi particle-size analysis of <2mm fraction from three selected Excavation Units (1, 7 and 13) was undertaken. It revealed similar particle-size characteristics for each of the Excavation Units (Fig.12). For each of the samples

there are peaks at 2.5 (180µm) and 4.0 phi (63µm). This analysis indicates that the deposit has a particle size distribution similar to that obtained from sediments in Holocene sandplains of aeolian origin found to the south in the Currawinya National Park to the south (Robins, 1993). The similarities suggest that much of the sediment in this deposit may also be aeolian in origin, although further work is required to test this proposition.

Munsell soil colours are consistently brown to dark brown (7.5YR 3/2-4/2) (Table 2). Soil reaction is 6.4 in XU 1 and XU 7 but declines to 4.4 in XU 13. Loss on ignition indicates a high carbon content ranging from 18.5% in XU 1 to 12.0% in XU 13.

This deposit has a complex history that is the result of roof fall combining with aeolian deposits blown in from the surrounding plateau. To this has been added a significant human contribution in the form of ash and charcoal from fires and other cultural material. The relative contribution of these sources has varied throughout time.

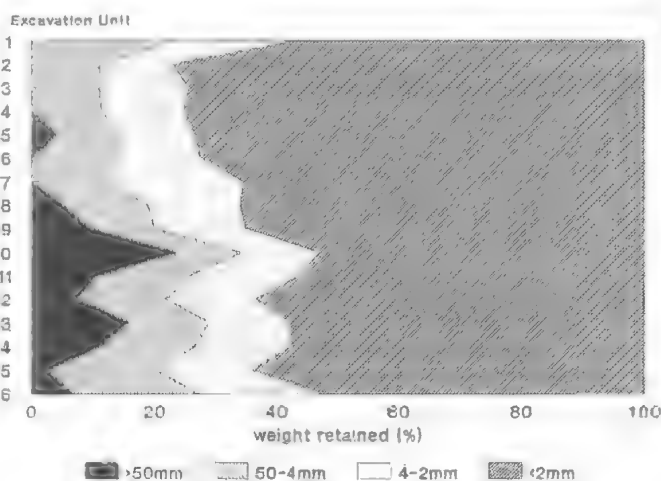


FIG. 15. Gross texture of XUs sieved in the field, excavation J9, Kyeenee I rockshelter.

TABLE 5. Frequency, size and mass of artefacts recovered from excavation J12, Kyeene I rockshelter. Abbreviations: XU=Excavation Unit; ML=Mean length; MW = Mean width; MM = Mean mass.

XU	Artefact Type	No.	ML (mm)	MW (mm)	MT (mm)	MM (g)
J12/1	Flake	1	16.2	22.2	3.5	11.25
	Core	1	60.8	41.8	25.8	71.4
J12/3	Flake	1	32.1	23.1	10.3	3.5
J12/4	Flake	1	42.5	22.2	13.0	8.8
J12/5	Flake	2	8.0	7.8	1.2	0.6
J12/7	Flake	4	12.4	10.4	5.5	2.6
	Flaked piece	3				0.6
J12/8	Flake	4	12.1	14.4	5.0	1.2
	Flaked piece	2				0.6
J12/10	Flake	4	22.3	19.4	8.5	5.1
J12/11	Flake	1	8.85	8.8	1.6	.09
J12/13	Flake	3	28.6	16.5	8.6	5.7

FAUNAL REMAINS

A small amount, 17.7g, of bone was recovered from the deposit. The individual pieces were unburnt, small and fragmentary. Animals represented include bird, rodents, macropods, possum, and snake. Due to the type and condition of the bone, identification to species level was generally not possible. A list of remains is presented in Table 3. The presence of these bones in the rock shelter does not necessarily indicate human predation. Such remains could, and probably did, result from natural deaths or were the prey of other animals that used the shelter from time to time.

FLORAL REMAINS

One hundred and twenty two grams of organic remains were found throughout the excavation (Table 4). The majority of remains were *Acacia* spp. phyllodes or *Eucalypt* spp. leaves and fruit. As these species are common to the site today it is not possible to determine if they were introduced by the human occupants of the rockshelter or were blown in. None of the remains were charred or burnt.

CULTURAL REMAINS

Stone Artefacts. Twenty-seven stone artefacts (all silcrete) were

recovered including 21 flakes, 5 flaked pieces and 1 core. A summary of artefact types is given in Table 5. This small number of artefacts restricts detailed analysis. Almost half the artefacts occurred in XU 7 and XU 8.

In general, the flakes tend to be as wide as they are long. The mean length to width ratio of flakes identified is 1:1.2 (Table 5).

The assemblage is generally small in size. For example, the maximum flake length is 42.5mm and the minimum 4mm. Despite the large amount of charcoal in the deposit there was little evidence of heat damage to artefacts. Only the core showed evidence of exposure to heat in the form of pot-lid scars on the cortex.

Wood Shavings. A total of twelve wood shavings were found in XU 4 to XU 7. Two types were identified. Ten shavings were from a dark wood and had a pronounced curl. Two were from a lighter wood and were shorter in length (Fig.13).

Charcoal. Charcoal was found in abundance throughout the deposit. A total of 2.2kg was recovered in the 2mm and 4mm sieves from all Excavation Units (Fig. 14). The charcoal was in large pieces, firm and in very good condition. XUs 5, 6, 7 and 11 each had over 250g. Only Excavation Units 1, 2, 3 and 12 had less than 100g (Fig. 14). Charcoal retained in the 4mm sieve from XU 13 provided a date of 1580 ± 60 BP (Beta 11591) and from XU 5 a date of 890 ± 50 BP (Beta 61794).

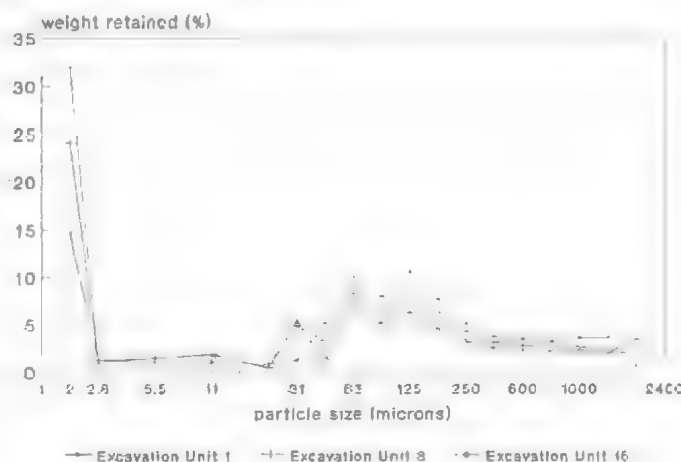


FIG. 16. Particle-size distribution in the <2mm field-sieved fractions from XU 1, 8 and 16, excavation J9, Kyeene I rockshelter.

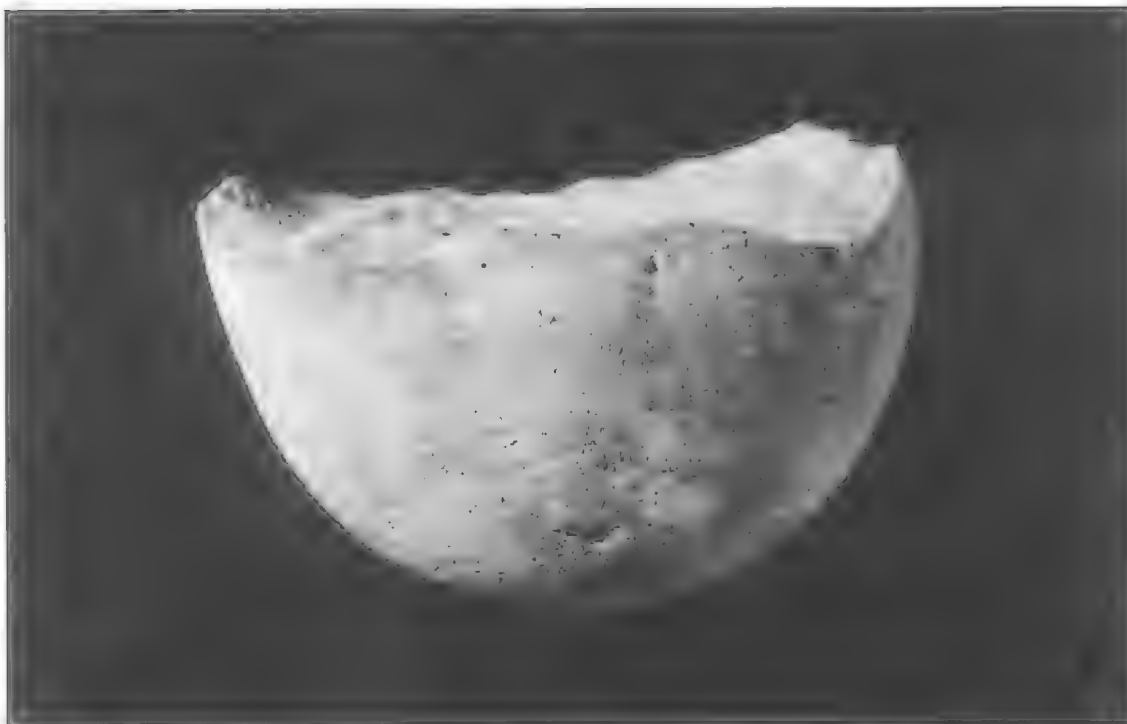


FIG. 17. Pebble core, XU 5, Excavation J9, Kyeenee I rockshelter.

J9 PROFILE DESCRIPTION

J9 contained 65cm of deposit. It was excavated in 16 XUs and produced 162kg of deposit. Four Stratigraphic Units were identified in the profile (Fig. 10).

Stratigraphic Unit 1 consists of a thin, fine, dry, grey to reddish grey layer (5YR 5/1-5/2) with loose gravel and humic material. Some forbs were growing on the surface and rootlets were evident throughout. It is 1-2cm thick.

SU 2 is a moister, more compact brown to dark brown layer (7.5YR 5/3-4/3) with an increase in finer sediment. The deposit is slightly drier and lighter with depth. This Stratigraphic Unit has a diffuse and irregular boundary that blends into SU 3. Its maximum thickness is approximately 25cm.

SU 3 is a dry, dark grey, (7.5 YR N4) unit that made up the bulk of the deposit. It lies on an uneven bedrock base and is coarser and less cohesive than SU 2. A number of large stones are present throughout. A small burrow is evident in the southwest corner. It has a maximum thickness of approximately 45cm.

SU 4 is a small lens that intrudes into SU 3 in the southeast corner. It is similar in colour and

texture to SU 2 and may represent a burrow from SU 2 into SU 3.

J9 SEDIMENT ANALYSIS

The J9 deposit is more compact, and does not exhibit the complex stratigraphic detail of J12. (Fig. 12). However, while not evident in the profile, analysis of the deposit reflects a more subtle complexity of depositional history.

Increase in clays by weight with depth and the decrease in sands by weight with depth may be attributable to postdepositional weathering and erosion, particularly as J9 lies near the edge of an erosion gully. Deposits of J12 inside the shelter are not as compact and show a more consistent relationship in particle-size distribution with depth. Further work is needed to test this explanation.

Overall, sieving data indicate a similar pattern of deposition to that of J12 (Fig.15). However, the lower XUs have a higher percentage of coarse fractions in them compared to J12. The proportion of stones >5cm is up to 23.5% by weight in XU 10. J9 has four peaks in the coarse fractions, at XUs 1, 10, 13/14 and 16 (Fig.15). The finer fractions (<2mm), vary from between 75.3% and 52.3% by weight, with a general diminution in



FIG. 18. Pebble core, XU 14, Excavation J9 Kyeence I rockshelter.

representation in the lower XUs. There is a marked increase in the weight representation of the 50-4mm and 2-4mm fractions at the surface - the only place where their increased contribution is not accompanied by a similar increase in the >50mm fraction.

The particle-size analysis at half-phi intervals of samples from selected XUs (1, 8, and 16) reveals a particle-size distribution similar in pattern to that of J12, with two important exceptions. The first is the segregation and subduing with depth of the 125 μ m and 63 μ m sizes (Fig. 16). The second is the increase in the clay fraction with depth; from 15% at the surface to 31% at the base.

There is minor colour change with depth. The surface wet and dry colours are brown to dark brown changing to very dark brown and dark greyish brown at the basal unit (Table 6). Soil reaction (pH) varies from 5.15 to 3.49 (Table 6). The carbon varies from between 13.28% to 11.0% and does not show any obvious depth-related trend.

FLORAL REMAINS

Five unidentified seeds were recovered from J9. Three were from XU 8 and two from XU 10.

CULTURAL REMAINS

Stone artefacts. Eighty five silcrete stone artefacts were recovered including 60 flakes, 14 flaked pieces, 6 retouched flakes and 5 cores. The distribution of artefacts throughout the deposit is relatively even. No artefacts were found in XU 15 or XU 16 (Table 7). No evidence of heating was noticed on the artefacts although a pot-lid flake and pot-lid scars were noticed on non-cultural stones in XU 9.

As with J12, the flakes tended to be small and as long as wide. The longest flake was 83mm and the shortest 4.4mm. Mean width-to-length ratio for all flakes was 1:1.24. Retouched flakes tended to be larger than the flakes, with a mean length of 20.6mm, although the width to length ratio remained similar at 1:1.4. Only one core, with a maximum length of 132mm and a mass of 1,338g, can be considered large compared to the rest of the assemblage.

More artefacts were recovered from J9 (85) than J12 (27). This may be attributed to one or more of four factors. These explanations are not mutually exclusive:

1) There was greater discard of artefacts on the terrace than in the rockshelter (cultural factor).

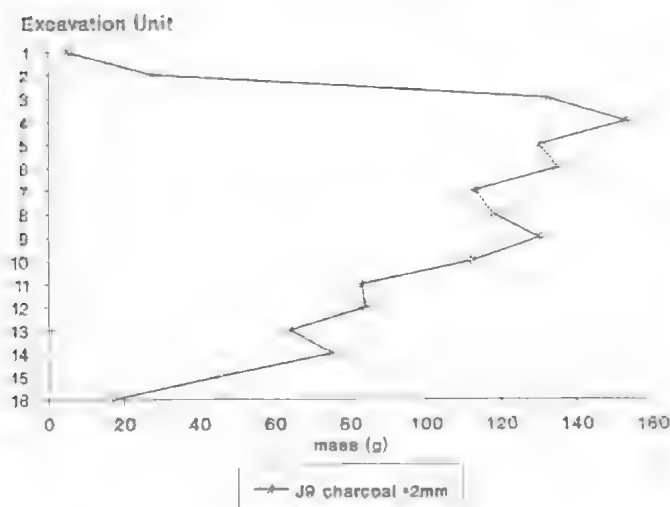


FIG. 19. Charcoal remains from excavation J9, Kyeenee I rockshelter

2) Artefacts discarded in the shelter were eroded downslope onto the terrace (taphonomic factor).

3) Artefacts on the surface above the rockshelter had been eroded downslope and onto the terrace outside the shelter (taphonomic factor); and

4) The sample of deposit is not representative with respect to artefact distribution (sampling factor).

A more extensive excavation and detailed examination of artefact distributions of the site would be needed to test these.

The two pebble cores are of some interest. They are the only artefact of their type observed during archaeological investigation's phase either in the vicinity the Currawinya Lakes or on Kyeenee (Robins, 1993). Both were recovered from this square J9; one from XU 5 and one from XU 14. The former is formed on an ovate, waterworn silcrete pebble. It has been substantially reduced from one end through a series of flakes removed along one margin (Fig. 17). A number of small flake scars with step terminations emanate from the platform. This flaking has formed a dentated, arcuate platform margin. The second pebble core has also been formed on a small, ovate, waterworn pebble and exhibits similar characteristics to the previously described specimen (Fig. 18). This example has a straighter, although more dentated, platform margin. One large flake has been removed from the end opposite the flaked edge. The platform also has one large and several small flakes removed from it. These cores occur in an area with an abundance of raw material. The steeply dentated and step-flaked margin is remi-

niscant of the edges produced for adzing tools, such as tulas, and may imply that the cores were used as adzes (although it is to be noted that dentated and step-flaked margins can be produced as a result of flaking cores).

Charcoal. A total of 1.4kg of charcoal was recovered in the 2mm and 4mm sieves from all XUs (Fig. 19). Although J9 only had just over half the amount of charcoal recovered from J12, a similar pattern of distribution emerged. In both cases there is little charcoal at the surface, an increase in the top one third of the deposit, followed by a diminution in representation to the respective bases of the excavation (cf. Figs. 14, 19). Charcoal re-

tained in the 4mm sieve from XU 15 provided a date of 1280 ± 70 yBP (Beta 11592), and from XU 8 a date of 660 ± 60 yBP (Beta 61793).

Faunal Remains. Two small fragments of unidentifiable burnt bone were recovered from XU 9 and XU 12.

OTHER ARCHAEOLOGICAL EVIDENCE

On the plateau surface above the site, the surface is bedrock which is devoid of vegetation but covered with silcrete gibber varying in size from 1-20cm in diameter. Nodules of silcrete embedded in the bedrock have been comprehensively flaked. There is also an extensive scatter of artefacts on this surface. A 10x10m quadrat was laid out on this surface, directly above the rockshelter where a shallow depression directs surface water over the lip of the shelter onto the terrace below. Two thousand and eighty two silcrete artefacts were recorded in this quadrat, including 1,807 flakes, 146 cores, 40 multi-platform cores and 89

TABLE 6. Carbon content, colour and soil reaction for selected Excavation Units in Excavation J9, Kyeenee I Rockshelter. Abbreviations: XU=Excavation Unit; SR=Soil Reaction; C. (Av.)=Carbon (Av.).

XU	% C. (Av.)	Munsell Colours		SR (pH)
		Wet	Dry	
J9/1	12.6	7.5 YR 3/2 dark brown	7.5 YR 4.2 brown to dark brown	5.2
J9/8	13.3	10 YR 3/1 very dark grey	10 YR 4/2 dark greyish brown	4.0
J9/16	11.1	10 YR 2/2	10 YR 4/2 dark greyish brown	4.6



FIG. 20. Kyeenec II rockshelter

retouched flakes. Artefact densities within the quadrat varied from 10-30/m².

Ninety percent of the flakes are between 1-5cm in length, the remainder are between 6cm and 8cm in length. Maximum flake size is 8cm, minimum is 13mm. Seventy five percent of the cores are 60mm-75mm long, the remaining 25% are 30mm-50mm long. Maximum core length is 75mm, minimum is 30mm.

A small, indistinct stone arrangement is located on the gibber strewn surface plateau surface op-

posite the rock shelter. The arrangement has deteriorated to the point where the only identifiable feature remaining is a small mound with a cleared centre.

SUMMARY

Sedimentary deposits in the Kyeenec I rockshelter contain evidence pointing to late Holocene human occupation commencing at about 1500yBP. It does not necessarily imply the earliest human use of the rockshelter. The deposits formed through a combination of aeolian activity which brought sand and dust inside the rockshelter, there to combine with roofall and

TABLE 7: Frequency, size and mass of artefacts recovered from excavation J9, Kyeence I Rockshelter. Abbreviations: XU=Excavation Unit; ML=Mean length; MW = Mean width; MM = Mean mass.

XU	Artefact Type	No.	ML (mm)	MW (mm)	MT (mm)	MM (g)
J9/1	Flake	2	29.6	15.8	8.9	11.5
J9/2	Flake	2	6.7	7.2	1.6	0.1
	Retouched flake	3	23.2	14.3	5.9	2.8
	Flaked piece	3				0.1
J9/3	Flake	3	17.9	18.0	4.8	2.2
	Retouched flake	2	51.5	36.1	15.8	21.8
	Flaked piece	1				20.1
J9/4	Flake	5	12.1	11.6	3.8	0.5
	Flaked piece	2				0.1
J9/5	Pebble core	1	23.2	14.5	9.9	4.3
J9/6	Flake	4	17.3	18.8	4.7	4.8
	Retouched flake	1	49.2	28.8	14.6	29.7
J9/7	Flake	5	12.5	12.6	4.4	1.3
	Core	1	73.5	50.0	42.9	145.1
	Flaked piece	2				0.2
J9/8	Flake	6	29.6	20.0	6.9	11.9
J9/9	Flake	4	9.7	7.2	1.6	.01
	Flaked piece	2				.01
J9/10	Flake	8	15.0	9.4	3.4	1.6
	Core	2	139.6	97.6	50.3	768.9
	Flaked piece	3				.01
J9/11	Flake	9	18.2	13.9	4.3	14.2
	Core	1	58.3	56.0	18.2	60.6
J9/12	Flake	4	27.2	22.3	7.4	24.7
J9/13	Flake	6	10.1	8.7	1.6	0.2
	Flaked piece	1				0.06
J9/14	Flake	1	15.3	11.2	4.5	.93
	Pebble Core	1	17.6	12.5	12.6	2.74

occupational material including stone and wooden artefacts and charcoal. The faunal and floral material found in the deposit has an equivocal history and may derive from human and/or non-human sources.

This shelter contains evidence of a range of human activities including stone and wooden artefact manufacture and maintenance, and burning. The large amounts of charcoal in the deposit indicate major episodes of burning. These episodes of burning appear to be unrelated to those of woodworking or stone artefact manufacture, maintenance or discard as the burning has not affected the other forms of evidence. The inter-

pretation of episodic burning events is reinforced by the preservation of floral and faunal remains that also appear to be unaffected by the burning. The infrequent and episodic human occupation is indicated by the generally sparse nature of the evidence of occupation at the shelter. The argument for episodic use of this site by people is further strengthened by the faunal evidence. If the faunal remains are non-humanly derived it implies that visits by humans were sufficiently infrequent for other animals to have occupied the site in their absence.

The area immediately surrounding this site expands the evidence of usage. The presence of the stone arrangement opposite the shelter indicates that the area was probably used for ceremonial activities. On the plateau surrounding the site, the extensive and dense artefact scatter argues for the secular use of stone, and if density of artefacts can be related to intensity of use this area was used more frequently than the rockshelter. Artefact maintenance and manufacture represents a significant proportion of that use.

This site can be interpreted as one that has played host to people who have carried out a variety of tasks at the site during short-term, episodic visits.

KYEENEE II ROCKSHELTER

Kyeence II rockshelter is located on the eastern side of a small outlier which is in a pocket of gently undulating mulga plains (Fig. 6). At approximately 2km from the rockshelter, Dissected Residuals encircle this plain on its eastern, northern and western sides. The ephemeral, dendritic drainage channels of Werie Ella Creek, a tributary of Benanga Creek, have formed approximately 1km the west.

The outlier, formed in Winton Formation bedrock, is approximately 250m long on its north-south axis and 74m wide at its widest point. Resistant bedrock has resulted in a small 3m high escarpment in which three rockshelters have formed (Fig. 20). The steep escarpment in which the rockshelter is located gives way to a gentle scree slope. This scree slope consists of boulders of weathered mudstone and siltstone, lithosols and shallow red earths supporting gidgee (*Acacia cambagei*) tall open mulga (*Acacia aneura*) shrubland (Dawson, 1974).

The rockshelter entrance is low (1.6m) and wide (6.4m) and 2m from the entrance opens out to 7.6m. Three metres from the entrance this chamber constricts to a small, 80cm wide hole



FIG. 21. Plan of Kyeence II rockshelter

that provides access to an inner chamber that is 4m wide and 2m deep (Fig. 21). The roof of the cave is low throughout, with a maximum height of 1.6m near the dripline (Fig. 22). Swallows nest on the ceiling, bats roost in the inner chamber and kangaroos and wallabies use the outer chamber.

Although other rockshelters in the outlier contained deposits with charcoal and artefacts on the surface, they had been extensively disturbed by animals. KRS II had a similar amount of deposit, but appeared to be less disturbed. It was selected for excavation on this basis. The rockshelter floor consists of fine grey sediment mixed with roof fall. In parts of the floor, bedrock was exposed.

At the time of investigation, two flakes and some charcoal were observed on the rockshelter floor. A number of artefacts were also scattered down the scree slope. Although the topography of the rockshelter indicated that the floor deposits were unlikely to be thick, it was hoped that its excavation would provide some *in situ*, dateable evidence of occupation and add to knowledge of the character of deposits in the region.

EXCAVATION PROCEDURE

After positioning a datum point outside the shelter, an alpha-numeric 50 x 50cm horizontal

grid was established for the floor using 90° offsets from the baseline. Heights were determined with autotest and water levels. One 50cm square, C3, was selected for excavation to obtain the maximum depth in the least disturbed deposit. It was then excavated following the procedures and pro-forma outlined by Johnson (1979). The excavated material was sieved through 2mm and 4mm wire mesh. All the material retained in the sieves was sorted on site. The >4mm material was sorted a second time on site and returned as backfill. The 2-4mm fraction was wet sieved. A grab sample (100g) of the material that had passed through both sieves was retained for further analysis. The excavated pit was lined with plastic and back-filled with rocks and excavated deposit.

Two 10m squares were laid out from the baseline to extend down the talus slope. All the artefacts occurring within these quadrats were recorded in a manner similar to that undertaken for the surface and other excavated sites.

DEPOSIT DESCRIPTION

C3 had a mean deposit depth of 11cm. Thirty seven kilograms of deposit was excavated in three XUs. The deposit consisted of fine grey sediment mixed with roof fall. The >2mm sieved fraction represented between 30% and 35% of the mass of the deposit throughout. Charcoal is pres-



FIG. 22. Topographic profiles across Kyeence II rockshelter

ent only in minor amounts but a trend of decreasing content towards the top was detected. The base of the deposit rested on uneven and weathered bedrock.

Detailed analysis of the deposit did not proceed because no artefacts or other cultural material were recovered.

ASSOCIATED ARCHAEOLOGICAL EVIDENCE

On the talus slope, the 10m square laid out from the baseline contained 38 silerete artefacts. The artefact types recorded included 25 flakes, 9 retouched flakes, 2 single platform cores, 1 multi-platform core and 1 tula. The maximum artefact density was 3/m². All the flakes had lengths of between 20mm and 65mm. The cores ranged in size from 15mm to 75mm.

The adjoining quadrat contained 87 silerete artefacts including 59 flakes, 7 retouched flakes, 13 cores and 8 multi-platform cores. All were made on silerete. Flake lengths ranged from between 25mm and 90mm. Eighty percent of these were between 25mm and 50mm in length. The cores ranged in size from 30mm to 75mm.

SUMMARY

The sediments in and around this rockshelter contain limited evidence of human occupation.

The deposit is shallow and in parts disturbed. Numerous artefacts litter the scree slope in front of the shelter indicating the possibility that either the slope was the preferred area for human activities or that the deposit in the rock shelter has been purged, perhaps a number of times, and the contents of the shelter strewn over the slope.

DISCUSSION

Although only a small sample, the excavation of these three rockshelters provides some basic evidence about the nature of archaeological deposits in rockshelters in southwest Queensland.

In each case, the rockshelters had been well formed, ranging from 4m to over 12m in depth. All were formed in the sediments of the Winton Formation which were capped with tertiary silerete bedrock or gibber. The depth of deposit in each case was relatively shallow, ranging from 6-80cm. The rockshelter directly associated with a source of temporary water had the deepest and culturally richest deposit. The deposits of the rockshelters that were a considerable distance from water sources (Murderers Bore 1 and Kyeene Rockshelter 2) were shallower and had little cultural evidence associated with them, al-

though the talus slopes in front of each were littered with stone artefacts, indicating some cultural use. The two deposits that were dated were late Holocene in age (450 ± 70 yBP and 1580 ± 60 yBP).

These investigations confirm the impression that the rockshelters of southwest Queensland are unlikely to contain deposits that are old, culturally rich or deep. Rockshelters that are considerable distances from sources of permanent or semi-permanent water will be less likely to contain deposits than those that are close to a water source. However, Kyeene Rockshelter had excellent preservation conditions and a range of organic material had been preserved in it. While these rockshelters may not represent a good source for obtaining long chronological sequences, under the right circumstances they may well provide a useful source of information for late Holocene Aboriginal occupation of this landscape.

ACKNOWLEDGEMENTS

This project would not have been possible without the support and assistance of Greg Sherwin from Kilcowera and Colin Vagg from Kyeene. Their co-operation and assistance for what must have seemed a never ending saga is much appreciated. This project would not have been possible without the help in the field of Julia Findlay, Rob Neale, Andrew Border and Richard McKellar. The forbearance and support of my colleagues Michael Quinell, Tina Baum and Judith Bartlett is appreciated. Steve Van Dyke assisted with mammal identification, Patrick Couper with reptile identification, and the Queensland Herbarium with plant identification. Grant McTainsh and Errol Stock provided useful comments and advice on the soil samples. Peter Hiscock, Peter Veth and Mike Smith kindly provided unpublished data and references. Natalie Franklin provided access to information from DEH records. Tracy Adams undertook the soil analysis. Grant McTainsh, J. Hall, Glen Ingram, Errol Stock and Bruno David read drafts and provided comment and advice. John Richter produced the illustrations. Vedette McGuire and Jody Niethe typed various drafts of the manuscript. I would like to thank the Queensland Museum Board and Peter Jell (Assistant Director, Research) for their generous support for this project. The Australian Heritage Commission, through the National Estate Grants Programme, contributed funds.

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GLOSSARY

Definitions for Stone Artefacts

Flake: A flake was defined as a piece of stone struck from a core and which exhibited characteristics which indicated that it had been struck. These included features associated with the point of force application (PFA) manifest principally in the presence of a ringcrack, a bulb of force on the ventral surface and other surface deformities including ripples, and an ecrassement scar (Hiscock, 1986).

Core: A piece of stone with no positive flake scars but with one or more negative flake scars (Hiscock, 1986).

Retouched flake: A flake which has had other flakes removed from it leaving scars onto the ventral face and/or deriving from the ventral surface (Hiscock, 1984).

Flaked piece: A chipped artefact which is missing the defining attributes of a core, flake or retouched flake. Some weathered, fractured or heat shattered artefacts are identifiable only to this level. This category is only used when the artefact had definitely been chipped, but its identification was uncertain (Hiscock, 1984).

Single platform core: A core from which all flakes have been struck from the same surface (the platform).

Multi-platform core: A core which has been rotated in the course of flaking so that flakes are struck from two or more surfaces. Commonly, flakes will be struck from negative flake scars on the core.

Snapped Flake: A flake which has been fractured transversely. These usually are elongate flakes (before fracture). The fracture surface is approximately perpendicular to the natural surface and often has a S-shaped undulation.

Tula: A flake with a convex ventral face and a large angle between the ventral surface and the platform. It has steep retouching at the distal end that extends around to the margins. The platforms are generally large and the flake is thick ventrally/dorsally (Hiscock & Hughes, 1983:96).

OBSERVATIONS ON THE EARLY LIFE HISTORY STAGES OF *NOTADEN BENNETTII* IN THE CHINCHILLA AREA OF SOUTHERN QUEENSLAND

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Sharman, M., Williamson, I. & Ramsey, D.S.L. 1995 12 01: Observations on the early life history stages of *Notaden bennettii* in the Chinchilla area of southern Queensland. *Memoirs of the Queensland Museum* 38(2):667-669. Brisbane. ISSN 0079-8835.

Eggs, larvae and metamorphs of *Notaden bennettii* were observed in natural pools in the Chinchilla area, southeast Queensland between February and March 1994. The observations suggest that *N. bennettii* has some interesting behavioural and morphological characteristics that are absent or rare in other Australian anurans. □ *Notaden bennettii*, life history, southeast Queensland.

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Notaden bennettii is a common frog found over a large area of inland eastern Australia (Cogger, 1992). However there is little information on the early life history stages of this species. We report here on observations of the eggs, larvae and metamorphs of *N. bennettii* made in the Chinchilla area of southern Queensland.

Observations were made at a site within the Barakula State Forest, approximately 40km north of Chinchilla in southern Queensland. Vegetation in the area is mainly open woodland dominated by white cypress (*Callitris glauca*). Observations were made in situ, or on live individuals transported to the laboratory. Descriptive terminology for tadpoles follows Altig (1970) and the staging system used is from Gosner (1960). Measurements of tadpoles were made to the nearest 0.5mm under a dissecting microscope, and metamorphs were measured using dial calipers. Water temperatures were recorded with maximum-minimum thermometers.

A number of permanent and temporary water bodies were monitored for calling males, eggs, larvae and metamorphs approximately once per week from November 1994 to March 1995. *Notaden bennettii* were heard calling on January 30, February 8 and February 14. Amplexed pairs were located on February 14 following 70mm of rain in the previous 48 hours. Amplexus was pelvic and pairs were seen in shallow temporary pools (10-20cm deep). Egg laying was not observed, but 15 egg masses were noted in four separate pools the following morning. Each mass was oval in shape and measured approximately 10x6cm. Masses were free floating, possibly due to a number of air bubbles distributed throughout the mass, and contained approximately 500 eggs in individual jelly capsules. In 13 of the 15 egg

masses a 2-3cm wide band of vegetation (mainly dead Cypress needles) was found around the perimeter of the egg mass (Fig. 1). The remaining two masses had only small amounts of vegetation around their perimeters. Because egg laying was not observed it is not clear whether each mass represents one clutch, and if adults placed the vegetation around the egg mass or if vegetation accumulated around the egg mass as it drifted in the pool. However, the small interval between observing amplexus and resulting egg masses (<12h) and the consistent arrangement of vegetation suggest that the vegetation was placed around the egg mass, perhaps to act as a barrier against egg predators.

Embryos in natural pools had hatched by 1200 on February 17 (approximately 60h). Embryos transported to the laboratory had reached stage 16

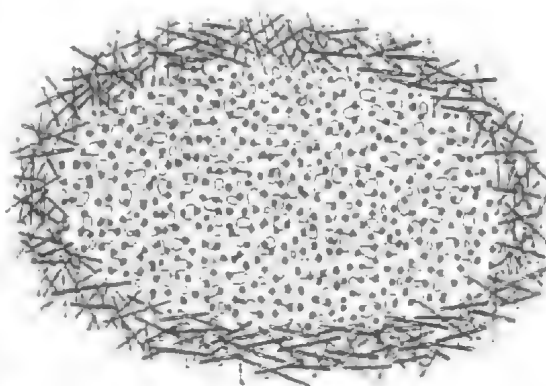


FIG. 1. Typical egg mass of *Notaden bennettii*. Masses measured approximately 10x6cm.

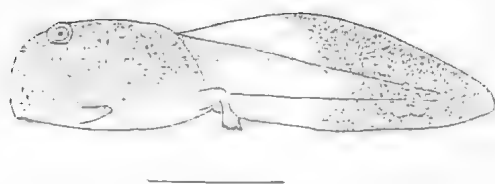


FIG. 2. Lateral view of a stage 37 *Notaden bennettii* tadpole. Scale bar = 10mm.

after approximately 36 hours, and stage 20 after approximately 60 hours. Temperature was not controlled during this period, but ranged between 20° and 30°C. Stage 26 tadpoles ranged in length from 7.5 to 10.0mm, and maximum length attained was 38.0mm (at stage 40). A stage 37 tadpole is illustrated in Fig. 2. Ratios of body proportions were body length : total length = 0.42 (n = 20), body width : body length = 0.63 (n = 10), and body depth to body width = 0.61 (n = 10). Eyes were dorsal and the mouth was orientated ventrally. There were three upper and three lower rows of labial teeth with the formula 3(2-3)/3, with the A2 gap being narrow and the A3 gap wide (Fig. 3). Marginal papillae had an anterior gap. The anus was median and the spiracle was sinistral, located ventrolaterally and orientated posteriorly. Tadpoles between stages 27 and 38 generally had a small pale spot mid-dorsally. The typical *N. bennettii* back pattern became evident at stage 37 to 38. A darkened posterior tail section developed from a slight difference in the distribution of dark pigment at stages 27 to 30, to a

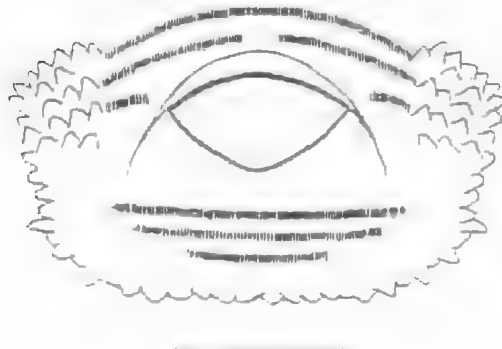


FIG. 3. The oral disc of a stage 37 *Notaden bennettii* tadpole. Scale bar = 1mm.

distinct dark posterior section in tadpoles beyond stage 36 (Fig. 2). Dark tail tips, with adjacent light areas, may function to misdirect the attack of predators (Altig & Channing, 1993), especially odonate naiads (Caldwell, 1982). Many tadpoles from natural pools had tail damage consistent with attack by odonates, and odonates were common in pools with *N. bennettii*.

In the field tadpoles were noted in the shallow water at the edge of pools at all times of the day. Recently metamorphosed individuals ranged in size from 11.0 to 14.9mm (mean = 12.7, n = 18). Metamorphs were noted near pools from February 28 to March 14. The length of the larval period in natural ponds is difficult to determine because pools with tadpoles of known age dried before individuals metamorphosed. Water temperatures in these pools ranged from 19° to 36°C. Some larvae in an experimental pond reached metamorphosis in 50 days (temperature range 19° to 36°C.). However, egg and larval period may be as short as 28 to 30 days if eggs were laid when frogs were first heard calling (January 30) and the metamorphs emerging from those eggs were the ones noted on February 28.

Metamorphs were active during the day and appeared to bask in sunny positions on the damp substrate. The meat ant, *Iridomyrmex purpureus*, was seen preying on some metamorphs. Other anuran species, noted as either calling males or as larvae, that used the same water bodies as *N. bennettii* were *Litoria alboguttatus*, *L. fallax*, *L. latopalmata*, *L. peronii*, *L. rubella*, *Cyclorana cultripes*, *Limnodynastes ornatus*, *L. tasmanien-sis*, *L. terraereginae*, *Crinla parinsignifera* and *Uperolea rugosa*.

Slater & Main (1963) described the tadpole of *Notaden nicholli*. However, information on the life history of the genus *Notaden* is limited. The observations presented here suggest that *Notaden bennettii* has some interesting behavioural (egg laying behaviour) and morphological (tail colour pattern) characteristics that are absent or rare in other Australian anurans.

Observations were made during field work conducted for the CSIRO - ANZECC Cane Toad Research Committee as part of a grant to I. Williamson. Steve Richards and Glen Ingram provided useful comments.

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FIRST RECORD OF THE LONGFIN MAKO (*ISURUS PAUCUS*) FROM AUSTRALIAN WATERS. *Memoirs of the Queensland Museum* 38(2): 670. 1995.—The longfin mako *Isurus paucus* Guitart-Manday, 1966 is a poorly known epipelagic tropical and warm-temperate shark which has been most frequently documented from the western North Atlantic (Compagno 1984). It has also been recorded from the eastern North Atlantic, central, western and western North Pacific and the western Indian Ocean off Madagascar (Fourmanoir & Laboute, 1976; Compagno, 1984; Taniuchi, 1984) but probably has a more extensive distribution in warm seas than these records suggest. Compagno (1984) noted that it is probably taken regularly in the Japanese tropical pelagic longline fishery. Last & Stevens (1994), in their guide to the sharks and rays of Australia, commented that this species 'still remains unrecorded locally but almost certainly occurs in oceanic waters off northern Australia'.

The apparent rarity of this species may in part be due to confusion with the shortfin mako *Isurus oxyrinchus* Rafinesque, 1809 from which it differs principally in its longer pectoral fins (about as long as head length), ventral head coloration and slimmer body.

The longfin mako has been reported to reach a maximum length of 417cm total length (TL); the size at birth is about 97cm and males and females are mature by 245cm TL.

Between 24 July and 27 August 1994, observers who regularly monitor the catches of Japanese longliners inside the Australian Fishing Zone reported several longfin makos as follows: 24 July at 32°S, 154°E, ♂, approx. 230cm TL, surface water temp. (WT) 19.8–21.1°C; 14 August at 14°S, 149°E, approx. 200cm TL, WT 23.8–24.0°C; 16 August at 14°S, 148°E, approx. 200cm TL, WT 23.7–23.9°C; 27 August, at 15°16'S, 151°16'E, at a hook depth of 50–145m, WT 24.6°C; 9 September at 15°9'S, 150°18'E, ♀, 201cm TL, 56.5kg, hook depth 60–190m, WT 24.0°. Full proportional measurements are available from the senior author.

Photographs of one specimen confirmed their identification (D. Heran, Foreign Fishing Observer Station, pers. comm.). On 9 September 1994, a 201cm TL specimen (Fig. 1) was caught by a longliner and retained by the observer (M. Scott) onboard at the time. This shark was subsequently sent to Hobart, photographed and preserved in the collection of the Tasmanian Museum and Art Gallery (Registration Number TMD 2241). Proportional dimensions of this specimen (after Compagno 1984) have been compared with those from the Indo-Pacific and central Pacific (Garrick 1967) and eastern North Atlantic (Moreno & Moron 1992). The only significant differences are that in the Australian specimen, the pectoral fins were 103.7% of head length (measured to the

pectoral fin origin) compared to a mean value of 102.0% for Garrick's (1967) specimens and 95.5% for Moreno and Moron's (1992) fish. Furthermore the Australian individual appeared to have a shorter snout than other compared specimens, however, this could be due to differences in measuring technique.

Acknowledgements

We are grateful to the Master and crew of the 'Vision' for transporting the longfin mako from the 'Kinsie Maru 5' to Cairns, Bob Lameson for arranging freight of the specimen from Cairns to Hobart, Wade Whitelaw and Noel Kemp for assistance with logistics, Grant West for help with the measurements and, together with Peter Last, for comments on the manuscript, Thor Carter for taking the photograph, the Commonwealth Observer Program for data on additional longfin mako specimens and the Master and crew of the 'Kinsei Maru 5', who caught the shark.

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Fig. 1. *Isurus paucus*, ♀, 201cm TL, captured at 15°09'S, 150°18'E off eastern Australia.

RE-APPEARANCE OF THE BLUE MUDHOPPER, *SCARTELAOS HISTOPHORUS* (PISCES: GOBIIDAE) IN THE GREATER BRISBANE AREA

K.A. TOWNSEND & I.R. TIBBETTS

Townsend K.A. & Tibbetts I.R. 1995 12 01: Re-appearance of the blue mudhopper, *Scartelaos histophorus* (Pisces: Gobiidae) in the greater Brisbane area. *Memoirs of the Queensland Museum* 38(2):671-676. Brisbane. ISSN 0079-8835.

Mudskippers have not been reported in the greater Brisbane area since 1919 (McCulloch & Ogilby, 1919). Recently, large populations of these animals were observed along the banks of the Brisbane River. A survey of the mudskippers in the greater Brisbane area was initiated and only the blue mud hopper, *Scartelaos histophorus* was identified. It has a discontinuous distribution from the mouth of the Brisbane River upstream to the suburb of Fig Tree Pocket and as far south as the suburb of Lota. Preliminary information on seasonal change in abundance for *S. histophorus* was obtained during this study. Future research areas based upon mudskippers as biological indicators are outlined. □ *Scartelaos*, ecology, distribution.

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Mudskippers are amphibious gobiids found in the muddy intertidal zones of tropical and sub-tropical coasts and estuaries. They are distributed from northern Australia to as far north as Kuwait Bay, including the east and west coasts of Africa, Melanesia, Micronesia, India, Polynesia and the West Indies (Stead, 1906; McCulloch & Ogilby, 1919; Marshall, 1966). The members of the Gobiidae that are commonly known as mudskippers are divided into the Periophthalminae and the Apocrypteinae; the former being more territorial. Representatives from both subfamilies have been recorded in Australia (McCulloch & Ogilby, 1919; Weber & DeBeaufort, 1953; Marshall, 1966; Milward, 1974; Grant, 1985).

The first record of mudskippers in the Brisbane area was of *Periophthalmus vulgaris* Eggert, 1935 (given as *P. koelreuteri* (Pallas)) in 1877 (Castelnau, 1878). Since that time no other study, including the comprehensive study conducted by Milward between 1964 and 1974 along the Queensland coast, had noted this species in the greater Brisbane area. Milward (1974) found the southern limit of *P. vulgaris* distribution to be Burnett River Heads (latitude c. 24°45'S).

In 1919 another species (*Scartelaos histophorus* (Cuvier & Valenciennes, 1837)) was noted in Moreton Bay and along the Brisbane River; identified as *S. viridis* by McCulloch and Ogilby (1919). This was the only report of these mudskippers in Australia until 1966 when a survey which included all of the eastern Queensland coast, noted *S. histophorus* to have a distribution no further south than Bundaberg (lat. 24°53'S) (Marshall, 1966). Milward's (1974) study ex-

tended the species' range to Urangan (lat. 25°15'S) in Queensland (Milward, 1974). Despite an extensive search for mudskippers in the greater Brisbane area, none were found (N. Milward, pers comm.).

The objectives of this study were two fold, firstly to identify the species of mudskippers found in the greater Brisbane area and secondly to survey the distribution and zonation of these species.

METHODS AND MATERIALS

Surveys of the distribution were carried out by visiting river and bay shores of western Moreton Bay, south east Queensland (27°22'S, 153°10'E). Additional information was obtained through interviews and reports supplied by members of the public, Brisbane Transport and university staff in response to newspaper articles. Written correspondence from the public was followed up by an interview by the principal investigator to confirm the identification of the animals, as often intertidal fish such as the peacock blenny (*Istiblennius meleagris* (Valenciennes)), family Blenniidae, were identified as mudskippers. This interview was then followed up with a visit to the reported location to confirm the distribution report. Through this process the general habitat of the animals was observed and potential sites for mudskipper populations identified.

Walking through the mudflats caused some difficulties as the animals were efficient at detecting movement which caused them to quickly retreat down their burrows. This made positive

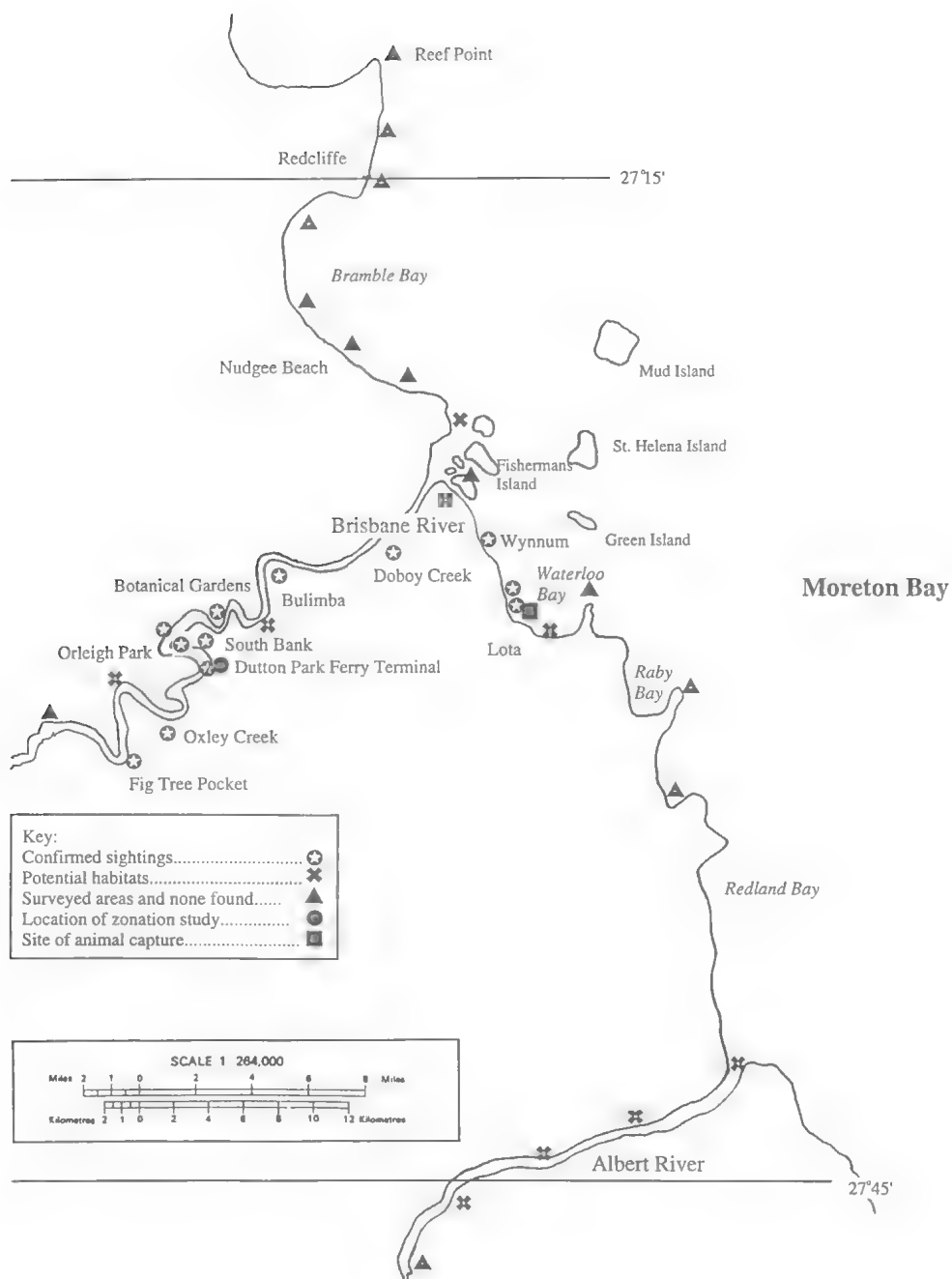


FIG. 1. Study sites and distribution of *Scartelaos histophorus* in the greater Brisbane area.

identification of the animals in the field difficult. specimens therefore had to be secured. The extent of the local distribution may have been underestimated as a result of disturbance to populations caused by the observer before the animals could be detected.

Many methods were employed in the attempts to capture specimens for identification. Past authors have noted this difficulty. D.G. Stead (1906) wrote "the capture of the little fish seems at first to be an easy task, but woe betide the reckless enthusiast who ventures on the treacherous ooze in its vain pursuit. He will emerge from the enterprise with bemired raiment and a much-chastened spirit!". Milward (1974) also tried many methods and was reduced to "patience and guile" to capture the fish, where as Stebbins and Kalk (1961) stunned the creatures using "rubber bands cut from automobile tires and fired from the thumb". For this study, attempts were made using a throw net, a nylon noose, a dip net and by simply attempting to chase and pounce upon them. The method that proved most successful consisted of stalking the animals at night during low tide with the aid of a spot light. Once dazzled the fish were scooped up using a bucket. The animals used for identification in the laboratory were captured by spotlighting in the Lota area.

The identification of the captured animals was done using a taxonomic key prepared by Milward, 1974. An ecological key developed from Milward (1974) and plates from Milward (1974) and Grant (1993) assisted with long range identification.

RESULTS

Spatial distribution: Only one species of mudskipper, *Scartelaos histophorus* (Apocrypteinae), was found in the Brisbane area during this study. Morphological characteristics of captive specimens were in agreement with the description given in the taxonomic key devised by Milward (1974). The body of the animal is elongate with very small scales. The dentition consists of sub-horizontal teeth in the lower jaw with caninoid teeth on each side of the symphysis. The second dorsal fin is elongate with 20 rays. The bulbous eyes contain a free lower eyelid and rows of short barbules are found on each side under the lower jaw. The colour of the dorsal surface in life is very similar to the substrate on which they live, with the ventral surface being white. When preserved, the animal takes on a slate blue colour from which

the common name blue mud hopper (Grant, 1993) may have arisen.

S. histophorus are found in areas containing substantial amounts of thixotropic mud (with a depth to the compact layer ranging from approximately 0.1-1m deep) and are usually associated with mangrove areas which undergo cyclic tidal emersion. Their distribution extends from the mouth of the Brisbane River, inland to the suburb of Fig Tree Pocket (Fig. 1). Visual searches did not uncover any animals from Nudgee Beach to as far north as Reef Point (Fig. 1). These areas, although containing apparently suitable habitats associated with mangroves, did not support communities of *S. histophorus*. The tidal flats associated with the suburbs of Lota supports a large colony (c.>1000) with potential distribution extending at least as far south as Waterloo Bay.

Temporal patterns - long term: Interviews were conducted with two employees of the Brisbane Public Transport service who have worked on the Dutton Park - University of Queensland ferry service for many years. They reported that they had not noticed the mudskippers until the summer of 1992. They kindly interviewed their co-workers, many of whom have worked on the Brisbane River for more than ten years, and they too confirmed this observation.

The owner of a local aquarium shop captured some of the animals when she first noted them, again the date reported was 1992. Information solicited from the Brisbane community via articles placed in local newspapers indicates that the mudskippers may have been present as early as the early 1970's in isolated pockets in the Wynnum area (M. Pearl, pers. comm.). The areas of Doboy Creek, Dutton Park Ferry terminus, Orleigh Park (J. Thomson, pers. comm.), Oxley Creek (D. Miller, pers. comm.) and the mud flats at Bulimba (R. Ritey, pers. comm.) were also identified as mudhopper habitats.

Temporal patterns - seasonal: Preliminary information on apparent seasonal change in abundance was obtained during this study. Animals were first observed by the authors following the first sighting of *S. histophorus* at Dutton Park Ferry terminus in the summer of 1992-93 and subsequently disappeared in the winter of 1993. They reappeared in October 1993 (late Spring). The number of animals noted during the present study (c.60) reduced sharply in March 1994 (late summer) until their disappearance in May 1994 (early autumn). The numbers of adult animals substantially reduced in numbers from the Dutton Park study site c. April 11-15.

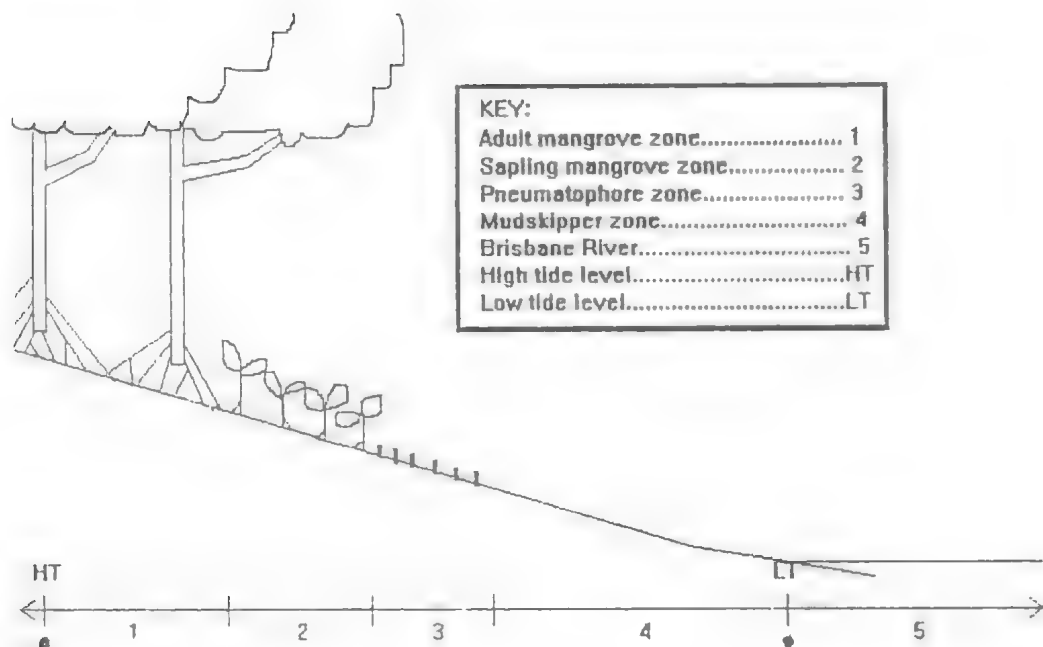


FIG. 2. Zonation pattern present on the shore of the Dutton Park ferry terminal.

At the start of the distribution observations only adult animals were sighted. The first juvenile (c.50mm total length) was recorded from Dutton Park study site on March 4. Juveniles were found in a different zone (the pneumatophore zone) from the adults and were still present at the study site after adult numbers had reduced substantially. By mid August 1994 no mudskippers of any age group were found to be inhabiting the site. All evidence of territories such as holes or shallow pools were no longer present.

Zonation: Animals at the Dutton Park ferry terminus are distributed in a distinct band across the shore. The shore at the Dutton Park Ferry terminus is divisible into four distinct zones (Fig. 2). The first zone consists of adult mangroves (*Avicennia* sp.) which grew close to the high water mark. The second zone adjacent to the first is the mangrove sapling zone which contains many fiddler crabs (*Uca* spp.). The third zone was the mangrove pneumatophore zone which contains small unidentified macrophthalmid crabs. Juvenile mudskippers were also found in this area during the months of April and May. Adult mud-

skippers are found only in the fourth zone from the edge of the pneumatophores (c. mid-tide level) to the low tide mark. *Scartelaos* only becomes active once the tide level had fallen below the pneumatophore zone. The "Scartelaos zone" (i.e. below the pneumatophore zone) was also apparent at the Lota study site. The Lota site also includes a fifth zone below the mudskipper colony to the low tide mark in which no animals are observed and thixotropic mud and seagrass dominates. This fifth zone was not observed at the Dutton Park site.

Patterns occurred in horizontal distribution as the animals were not uniformly distributed within the *Scartelaos* zone at the Dutton Park site. The area closest to the jetty contains several mating pairs with all solitary animals being excluded from the area. The area with many lone animals contained mostly displaying animals with very few pairs apparent and many agonistic interactions (Townsend, unpublished data).

DISCUSSION

This is the first detailed study of mudskippers in the Brisbane region. It reveals that either historical records and some detailed studies are less than accurate or that mudskipper range varies remarkably. *Periophthalmus vulgaris*, which had been previously reported in the greater Brisbane area (Castelnaud, 1878) was not found. Interviews with ferry staff and members of the Brisbane community indicates that *S. histophorus* has only recently reappeared in substantial numbers in the greater Brisbane area. Seasonal activity was recorded with a complete absence of the animals from the study site during the winter months of August through to mid October. The only other report of seasonality is for *Boleophthalmus pectinirostris* from Japan (Fukuda, 1994). The greatest activity of the animals occurring during the summer months from April to November and only moving to catch food during warm days of winter (Fukuda, 1994). The extreme seasonality of *S. histophorus* may be unique to the Brisbane area as this complete "disappearance" has not previously been reported.

It is hypothesised that the animals undergo either aestivation or migration away from the sites during the winter months. Berti et al. (1992) demonstrated the "homing" abilities of a *Periophthalmus* sp. from a delta in the Tana River (Kenya) and, although this ability was only tested at a maximum distance of 250m away from the territories, similar abilities would be necessary if migration does occur in *S. histophorus*. Alternatively, mudskippers may avoid extremes in temperatures by retreating into deep water-filled burrows (Tytler & Vaughan, 1983) therefore the animals may be aestivating during the winter months. Further study, via tag and recapture or burrow excavation, needs to be undertaken to test these hypotheses.

Mudskippers may prove to be convenient bio-indicators of estuarine health. Further research to this end may investigate the relationship between the benthic diatom community and the density and abundance of mudskippers. For example, subtle modifications of the benthic diatom community, due to anthropogenic effects, may lead to changes in the abundance and distribution of *S. histophorus*. In Japan, reduction of estuarine health due to polluted rivers has been pinpointed as one of the causes of reduced numbers of *Boleophthalmus pectinirostris* (Fukuda, 1994).

FUTURE RESEARCH

In addition, future research may be aimed at answering the following questions. Have the *S. histophorus* communities "returned" to the greater Brisbane area or were they isolated to pockets of fragmented habitat? Can the population change be attributed to pollution levels, substratum changes, increase in mean temperatures or other physical factors? Research should be aimed at identifying if the factors resulting in the changes of distribution of *S. histophorus* are due to environmental quality such as diatom numbers, sediment changes, chemical changes or due to anthropogenic effects or physical changes such as temperature and climate.

Unique to *S. histophorus* in the greater Brisbane area, is the disappearance during the winter months. Research into the activities of the animals during the cold winter periods may be investigated. Are they aestivating or do they undergo migration? Winter searches and tag and recapture methods may be employed to answer this.

Little is known about the factors resulting in the age structure, settlement and recruitment processes of *S. histophorus*. The vulnerability of the population needs to be identified. This paper highlights the need for further study to fully understand the role of *S. histophorus* in the Brisbane estuarine ecosystem.

ACKNOWLEDGEMENTS

We thank the following people for their help: Kevin Townsend, Melanie Venz, Peter Kind, all the kind responses from the Brisbane public, Ian Johnstone and Leigh Henderson from Brisbane City Transport, Coral McGregor from the Clayfield aquariums, computer help from Narelle Hall and Peter Fugelli and for the kind advice from Dr. Norman Milward.

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DEVONIAN THELODONT SCALES (AGNATHA, THELODONTI) FROM QUEENSLAND

SUSAN TURNER

Turner, S. 1995 12 01: Devonian thelodont scales (Agnatha, Thelodonti) from Queensland. *Memoirs of the Queensland Museum* 38(2): 677-685. Brisbane. ISSN 0079-8835.

Turiniid thelodont scales from the Emsian-Eifelian Cravens Peak Beds of the Toomba Range, Toko Syncline, western Queensland and the undifferentiated Broken River Group (late Emsian *serotinus* Conodont Zone to Givetian) of the Broken River Province of north Queensland are referred to *Turinia gavinyoungi* sp. nov. and *Jesslepis johnsoni* gen. et sp. nov. respectively. □ Devonian, Thelodonti, Turiniidae, Queensland.

Susan Turner, Queensland Museum, P.O. Box 3300, South Brisbane, Queensland 4101, Australia; 12 October 1995.

Early to Middle Devonian limestones from the Broken River Province, near Greenvale, north Queensland have yielded microvertebrate assemblages which include rare thelodont scales (Jell et al., 1983; Turner, 1991b, 1993). *Turinia* sp. cf. *T. australiensis* has been reported from the Martin's Well Limestone of Magpie Creek, Shield Creek Group at Broken River (Turner, 1993), and one possible turiniid scale has been found within the Givetian part of the Broken River Group. Within the Burges Formation (late Emsian-Eifelian) of the Broken River Group a series of thelodont scales have been found at various localities in the Burges and Wando Vale districts. In the Toko Syncline, western Queensland, a limestone member of the Cravens Peak Beds has also yielded abundant thelodont scales from shot point localities (Turner et al., 1981; Young, 1984, 1995). The scales from both locations are sufficiently dissimilar to those already known to warrant assignment to new taxa. They are referred to the Turiniidae which comprises 3 genera; *Turinia*, *Australolepis* and *Boreania* (Turner, 1991a). Turiniid thelodonts are now known from all continents in the Lower Devonian and are most longlasting in Gondwana, becoming extinct only in the early Frasnian.

Broken River samples were collected by J.S. Jell (The University of Queensland UQ Locality numbers, UQL) or during sampling for conodonts by John Talent and Ruth Mawson (Mawson et al., 1988; Mawson & Talent, 1989; Macquarie University, Centre for Elostratigraphy & Palaeobiology samples from SAG section); the type specimens are designated with Queensland Museum numbers (QMF). For recent summaries of Broken River geology see Withnall & Lang (1993) and Sloan et al. (1995). The Toko Syncline limestones were collected by John Draper and

samples specifically for fossil fish were obtained by Gavin C. Young (type specimens designated in the Commonwealth Palaeontological collection, CPC, based at the Australian Geological Survey Organisation, Canberra).

SYSTEMATIC PALAEOONTOLOGY

Superclass AGNATHA
Class DIPLORHINA
Subclass THELODONTI
Order THELODONTIDA
Family TURINIIDAE Obruchev, 1964

Jesslepis gen. nov.

TYPE SPECIES

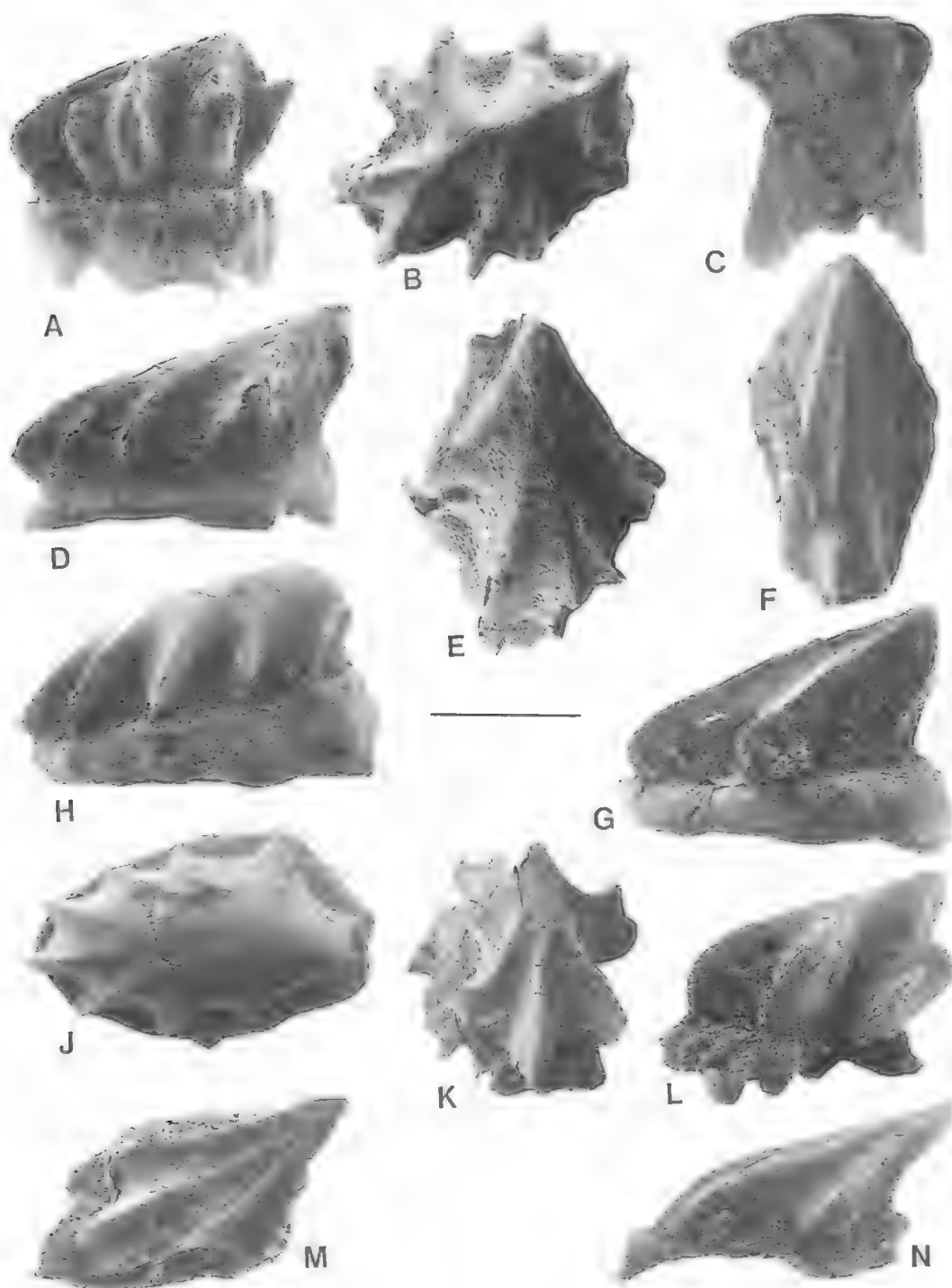
J. johnsoni sp. nov.

DIAGNOSIS

Small to medium-sized scales; large open oval to slit-like pulp cavity. Crown rises steadily from anterior to sharp posterior point at an angle of 30-45°. Sharply angled posterior point. Crown narrow, base low, neck virtually absent. Two to four deeply dissected crown ribs meet the crown-base interface at a steep angle. Crown ribs can extend from the anterior rim to the posterior point in a straight line.

REMARKS

Differs from *Turinia*, *Australolepis* and *Boreania* (eg., Turner, 1991a) in the general morphology of the crown, having a relatively smooth and steeply sloping upper surface in most scale varieties; elongate triangular or arrowhead-like outline; and the low number of crown ribs.



***Jesslepis johnsoni* sp. nov.**
(Figs 1, 2A-M)

1991b turiniid, Turner: 447.

1993 endemic thelodonts, Turner: 183.

DIAGNOSIS

As for genus.

MATERIAL EXAMINED

HOLOTYPE: QMF33724.

PARATYPES: QMF33721-3, 33725-40. 20 scales from UQL4703 youngest; UQL4704 (type locality); UQL4706 oldest; UQL4697; UQL4388; UQL4374; UQL4054, basal Lomandra Limestone, late Emsian and early Eifelian Broken River Group, (stratigraphically below Fish Hill Limestone Member, see Withnall & Lang 1993); SAG 2 (3 scales); SAG 8 (2 scales), SE of Arch Gorge section (Mawson & Talent, 1989; table 5) Chinaman Creek Limestone of Sloan et al. (1995).

DESCRIPTION

Scales mostly 0.5-1mm long. Oral or head scales (Fig. 2A) are rounded and cap-like in ontogenetically young scales as in most thelodont genera but can have deeply dissected crown ribs which can curve (Figs 1B,C, 2A,B). Cephalopectoral scales are more elongated and can have prongs midway on the lateral ribs (Fig. 1A,L). Lateral ribs can be curved (Fig. 1A, B,D, H) or straight (Fig. 1F-G,M). Postpectoral or trunk scales are narrow and arrow-shaped and generally longer than wide (Figs 1F, 2G,J). V-shaped scales (Fig. 1M) might possibly be from the pinnal or caudal regions. Bases are mostly as large as the scale and about one-third the height (Figs 1D,G-H, 2F,I,L) but can be shallow in ontogenetically young scales (Fig. 1L). Basal crenulations and lobules are common (Figs 1A,E,K-L, 2K,M) often mirroring the shape of the crown. In lateral view the posterior base seems deeper and forms a skirt-like extension (Figs 1D,G, 2C,I,L). The basal cavity can be a shallow central concavity (Fig. 2E) becoming reduced as the base grows to a small central pulp opening (Fig. 2H).

Histology. Internal examination by thin section or by anise oil immersion has not been possible because the blackened specimens are few in number. However, nearly all scales examined are

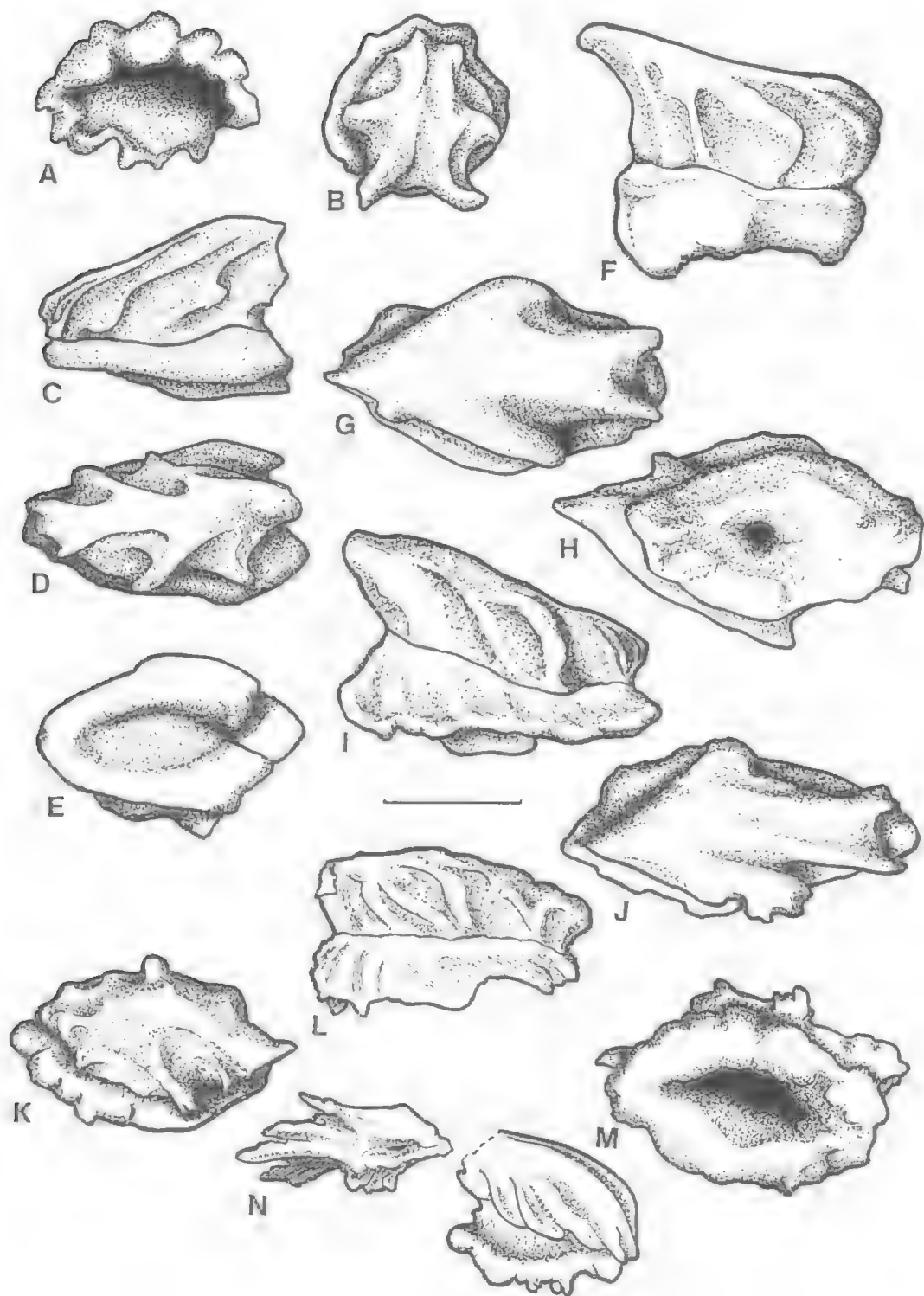
cap-like with a large wide-open pulp cavity but older scales with mature bases are seen (see above and Fig. 2).

AGE

The Burges Formation of Withnall & Lang (1993) has been referred to "undifferentiated Broken River Group" by Sloan et al. (1995). Upper and lower limits of the taxon are not well constrained but on the evidence of associated corals (Jell, pers. comm.) and conodonts from SAG section the possible range seems to be between *serotinus* and basal *ensensis* Conodont Zones.

Thelodont scales are rare in these marine limestones and for now, because of the potential range of variation within turiniid squamations, all but one of the scales found are placed in *J. johnsoni*. De Pomeroy (1994) recorded new shark genera from the Broken River sequence, mainly from the late Eifelian-Givetian interval (*kockelianus-varcus* Zones), associated with acanthodian, thelodont, placoderm, and osteichthyan remains. She has reported one thelodont scale from the Eifelian SAG section (De Pomeroy, pers. comm.) which has been referred to an indeterminate thelodont (De Pomeroy, 1995, in press, fig. 6M, N). This scale is referred to the new genus and most closely resembles the scale illustrated in Fig. 3B. The new scales described here come from a series of limestone samples, notably from the measured section "SAG" which has conodont control (Mawson et al., 1988; Mawson & Talent, 1989). There are now three scales from SAG 2, and two from SAG8. These scales occur 26.8 and 67m above the base of the sections respectively (Mawson & Talent, pers. comm.) SAG2 conodonts include *P. l. linguiformis* and *P. parawebbi*, which co-occur in the *australis* Zone (Mawson & Talent, 1989; fig. 9). Conodont elements, *I. struvei* and *P. l. klapperi* appear at 55.6m above the base of SAG section (Mawson & Talent 1989, Table 5). SAG8 would, therefore, appear to be close to the base of *ensensis* Zone. The new scales are associated with onychodont teeth and undetermined acanthodian scales, *Cheiracanthoides* cf. *comptus* (*C. comptus* s.s. is typical of latest Emsian-Eifelian; Turner, 1993), cosmine scales, shark scales (De Pomeroy, 1994) and possible shark teeth.

FIG. 1. *Jesslepis johnsoni* gen. et sp. nov. from UQL4704, Broken River Group, Broken River Province, Queensland, Australia. A, QMF33721, lateral view. B, crown view of A. C, QMF33722, lateral view. D, QMF33723, lateral view. E, crown view of D. F, Holotype QMF33724, crown view. G, lateral view of F. H, QMF33725, lateral view. J, crown view of H. K, QMF33726, crown view. L, antero-lateral view of K. M, QMF33727, crown view. N, lateral view of M. Bar = 0.5mm.



REMARKS

In common with other Australian turiniid scales (e.g. *Turinia australiensis*, *Australolepis seddoni*; Turner, 1991b), the new taxon shares some general characters such as the high crown, largeulp cavity and cap-like nature of most scales. However, micro-ornament is absent; this latter character appears in many of the Gondwanan species of *Turinia* and appears to have phylogenetic significance (Turner, submitted).

ETYMOLOGY

In honour of Dr J.G. ("Jess") Johnson (1932-1994), Devonian biostratigrapher and palaeontologist, and *lepis*, Greek; scale.

Turinia gavinyoungi sp. nov.
(Figs 2N?, 3)

1981 *Turinia* cf. *pagei*, Turner et al.: 54, figs. 6-8, 10J-L, 11H.

1991b *Turinia* n. sp., Turner: 447, pl. 5D, fig. 4B, E-G

DIAGNOSIS

Head and trunk scales large with high crowns. In trunk scales anterior median crown section narrow. Crown deeply dissected with ribs and lobes leading to a high central ridge culminating in sharp posterior point. Typically three pairs of lateral ribs. Ribs can be split and upturned. Multiplication of riblets and lappets on crown. Micro-ornament sometimes present. Concave neck. Base usually wider than crown and expanded anteriorly. Basal nodules common.

MATERIAL EXAMINED

HOLOTYPE: CPC 20079/3 in Turner et al., 1981, fig. 7E, a typical trunk scale from a small limestone outcrop in the southern part of Toomba Range, western flank of Toko Syncline, Georgina Basin, western Queensland, central Australia. Approximate latitude and longitude 23° 23' 47"S, 138° 08' 10"E (map and section in Turner et al., 1981, fig. 2; Turner & Young, 1987, fig. 1). Cravens Peak Beds: upper Emsian? - lower Eifelian, top Lower? - basal Middle Devonian (see discussion in Young 1995).

PARATYPES: CPC20079/1-2, 4-20, 20080/1-4 from sample GEO 65/28 (Turner et al. 1981); GB77.(loc. 11) G.C. Young coll. V1649, QM F33742-97 from same

locality as the type specimens. QMF33741 from UQL4374 Burges Formation of Broken River Province might belong to this taxon.

DESCRIPTION

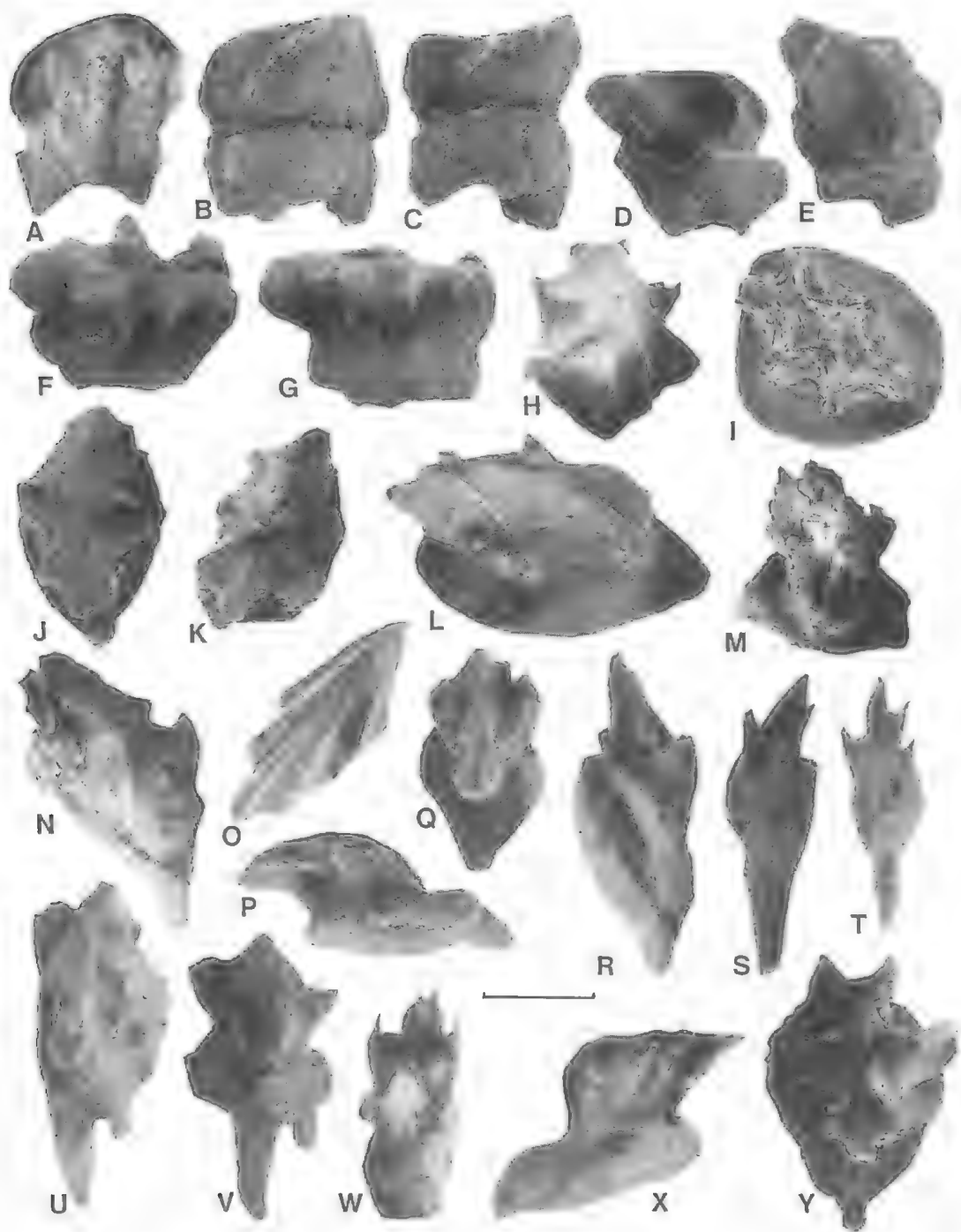
See descriptions and measurements given in Turner et al. (1981: 55); average length 1.5mm. Material from sample GB77 is figured here for the first time. Head/oral (Fig. 3A-C), cephalopectoral/transitional (Fig. 3D-L, Y?) and trunk scales (Fig. 3M-X) are found. Turner et al. (1981; figs 6-8) showed some of the range of scale variation. Crowns are typified by the outwardly expanding triangular lappets which end in many posterior points (Fig. 3M-N, R-W). The crown can be divided into five or more compartments by, typically, three pairs of deeply dissected ribs and lappets (Fig. 3J-L, Y). The posterior median part of the crown is sharply pointed and can be recessed below the crown ridge (Fig. 3R, W). Lateral ribs can expand into an upward turning projection at mid length or near the crown-neck interface (Fig. 3L, N, P). Multiple ribbing (Fig. 3M) and micro-ornament is seen especially on trunk scales (Turner et al., 1981; figs 7E-G, 8D, 10J). On the bases very long anterior processes are typical (Turner et al., 1981; fig. 8B; Fig. 3R-T) and commonly can be double but with one process longer than the other (Fig. 3U-V); this latter might represent an individual variation. Multiple basal lobules (Fig. 3B) can occur (Turner et al., 1981; fig. 8A).

Histology. Preparation in anise oil shows a typical turiniid dentine crown with thin durodentine cap surmounting a large base of aspidine penetrated by the canals of Sharpey's fibres (Turner, 1991a). Large pulp cavities are common (Fig. 3A). Although the dentine tubules seem relatively sparse, they are straight with few branches except at the proximal ends; no clearly specific attributes can be seen except where the dentine tubules are longer to reach into the expanded lappets and rib extensions.

REMARKS

Turner (in Turner et al., 1981) compared this form with the type species, *Turinia pagei* Powrie in its well-developed elongate high crown with a slight anterior notch. The scales differ in the more

FIG. 2. Broken River Group thelodont scales. A-M, *Jesslepis johnsoni*. A, QMF33728 head scale from UQL4054, basal view. B, QMF33729 from UQL4704, crown view. C-E, QMF33730 from UQL4704. C, lateral view. D, crown view. E, basal view. F-H, QMF33731 from UQL4704. F, lateral view. G, crown view. H, basal view. I-J, QMF33732 from UQL4388. I, lateral view. J, crown view. K-M, QMF33733 from UQL4388. K, crown view. L, lateral view. M, basal view. N, *Turinia gavinyoungi*?, QMF33741, broken scale from UQL4374. Bar = 0.5mm.



extreme development of lappets and partitions of the crown, seen particularly well in the trunk scales. Closely spaced double ribs are comparable with those of Givetian *Turinia hutkensis* Blicek & Goujet (1978) of Iran, whereas the out-turned ribs resemble those of the Eifelian to Givetian *T. pagoda* and *T. spp. A & B* of West Yunnan, China (Wang et al., 1986). The presence of micro-ornament suggests close relationships with the earlier *T. australiensis* group of scales, as well as to Givetian taxa, *T. pagoda* and *T. antarctica* Turner & Young (1992). The scales in the Cravens Peak Beds sample are robust and although the crowns can be well scalloped they do not exhibit the fragility and lightness seen in scales of the early Frasnian turiniid, *Australolepis*. One possible scale from the marine limestones of the Broken River Group with posterior extensions and lappets (Fig. 2N) might be a scale of *Turinia gavinyoungi*.

Thelodont scales outnumber acanthodian scales in the assemblage by approximately 4:1. The associated fauna includes climatiid spines, *Acanthodes* type and *Machaeracanthus* scales; scales and bones of an antiarch placoderm (Young, 1984); shark teeth *McMurdodus*, (Turner & Young, 1987) and various shark scales. Onychodont teeth are common as well as scales of a sarcopterygian. Lepidotrichia are also present. The samples appear to be relatively unaltered, the colour ranging from orange to rose quartz and, given the good preservation and lack of abrasion, the scales are unlikely to have been transported far.

ETYMOLOGY

For Dr Gavin C. Young, Devonian fossil fish worker, who collected much of the Cravens Peak material.

AGE

Based on the associated vertebrate assemblage, the present consensus favours an Eifelian age for the in situ limestones of the Cravens Peak Beds (Young, 1995). In the absence of conodonts the

evidence is provided by fish and crustaceans. P.J. Jones (in Turner et al., 1981) noted that the ostracods and the eridostracan from shot point samples and from GEO 65/28 were most like those of early Devonian age from the northern hemisphere. The thelodont in the shot point samples is *T. cf. australiensis* and thus could be as old as mid Lochkovian-Pragian or more likely early Emsian (Turner, submitted). *T. gavinyoungi* occurs in samples GEO 65/28 and GB77. Comparing this taxon with others known from Australia, from the nearby Ross River (Young et al., 1987) and Hatchery Creek Formation (Young & Gorter, 1981) where there are scales comparable with *Turinia* sp. of Khush-Yeilag and *T. hutkensis* of Iran (now thought to be of early Eifelian and late Givetian age respectively (Lelièvre et al., 1993), then an Eifelian age for *T. gavinyoungi* seems most probable.

SIGNIFICANCE

Work in the last decade has clarified the range and distribution of thelodont scales in Australian Devonian sequences (Turner, 1995; Young, 1995). Their usefulness as zonal or age indicators has been acknowledged especially in the absence of conodonts. The taxonomy of Australian thelodonts is better understood now that comparisons can be made from a series of different facies from many horizons throughout the Lower to early Upper Devonian and from several countries. With the aid of recent studies of conodont-dated sequences, the ranges of thelodont species have been refined (Turner, 1995; submitted; Young, 1995).

The new scales from north Queensland are unlike any previously described in the Devonian. In their simplicity they resemble earlier Silurian thelodont scales but the ubiquitous light-weight of the base with a large pulp cavity is a feature in common with the younger *Australolepis* of the early Frasnian of Western Australia. Further studies from conodont-dated sections should help to refine the range of *Jesslepis*.

FIG. 3. *Turinia gavinyoungi* sp. nov. from the Cravens Peak Beds of the Georgina Basin, Queensland, Australia. A-C, I? Head/oral scales. D-H, J-L, Y? cephalopectoral/transitional scales. M-X, trunk scales. A, QMF33742, internal sagittal section of broken scale. B, QMF33743, lateral view. C, QMF33744, lateral view. D, QMF33745, lateral view. E, antero-lateral view of D. F, QMF33746, crown view. G, lateral view of F. H, QMF33747, crown view. I, QMF33748, crown view of oral or special scale. J, QMF33749, crown view. K, QMF33750, crown view. L, QMF33751, lateral view. M, QMF33752, crown view. N, QMF33753, crown view. O, QMF33754, crown view. P, QMF33755, lateral view. Q, crown view of P. R, QMF33756, basal view. S, QMF33757, latero-basal view. T, basal view of S. U, QMF33758, lateral view. V, anterior view of U. W, QMF33759, anterior view. X, lateral view of W. Y, QMF33760, crown view. Bar = 0.5mm.

T. gavinyoungi is comparable with Early Devonian scales such as *Turinia pagei*, and *T. australiensis* but is more like Middle Devonian turiniids from elsewhere in Gondwana. As the Cravens Peak Beds contains no conodonts, assessment of the associated fauna has suggested the age of *T. gavinyoungi* as Eifelian (Young, 1995). However, the possibility that one scale from the conodont-bearing Broken River Group belongs to this taxon suggests that the age and range will be clarified by future sampling of measured sections.

ACKNOWLEDGEMENTS

I thank Dr John S. Jell (The University of Queensland) and Dr Gavin C. Young (A.G.S.O., Canberra) for allowing and enabling me to study material collected by them. Professors John Talent and Ruth Mawson (M.U.C.E.P., Sydney) gave freely of information regarding conodont dating of Broken River samples; Alison De Pomeroy allowed me to see unpublished data on her thelodont scale. An anonymous reviewer helped to clarify some points in the manuscript. Work on Australian microvertebrates has been supported by grants from the Australian Research Committee and is currently supported by an Australian Research Fellowship. I thank the late Gudrun Sarne (Queensland Museum), Dora Aitken (ARC funded) and Diane Phipps (The University of Queensland) for taking the SEM photomicrographs and Bruce Cowell (Queensland Museum) for providing photographic support. This is a contribution to IGCP 328: Palaeozoic Microvertebrates.

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APPENDIX

Broken River province (approximate latitude and longitude 19°144'40'E) sample locality details;
 UQL4703 (youngest), UQL4704, UQL4706 (oldest), south-folded limestones, traverse to road from Digger's Creek Crossing (BURGES 1:100,000 Sheet 7859: 683.489) stratigraphically below Fish Hill Limestone Member (see Withnall & Lang 1993).
 UQL4697 limestone about 70m W of old road crossing at Digger's Creek, stratigraphically below Fish Hill Limestone Member, see above.
 UQL4734 thin limestone in shale, north bank of Broken River upstream of Gorge (645.457);
 UQL 4388 thin crinoidal debris limestone, north bank of Broken River upstream from UQL4374 (644.458);
 UQL4054 western creek bank of Dosey Creek, 750m upstream from its junction with the Broken River (615.438), basal Lomandra Limestone, late Emsian;
 MUCEP samples SAG 2; SAG 8: SAG = a measured section through Chinaman Creek Limestone Member (Mawson & Talent, 1989, fig. 1, 4, table 5) commencing SE of Arch Gorge (at BURGES Sheet, 717.539) approximately 4.2km E of Jessey Springs Hut.

FIRST RECORD OF PARASITISM BY A TICK ON AN AUSTRALIAN FRESHWATER CROCODILE. *Memoirs of the Queensland Museum* 38(2):686. 1995:- I report an uncommon occurrence of the tick, *Amblyomma* sp., after encountering a nymph on a yearling freshwater crocodile, *Crocodylus johnstoni*. Although leeches and dermal nematodes are common ectoparasites on this crocodile (Webb et al. 1983), this is the first record of tick parasitism on any Australian crocodile.

The crocodile was captured during an ongoing study of *C. johnstoni* in the Lynd River of north central Queensland (Tucker et al., 1994). The crocodile (#3057) was marked as a hatchling on 18 December 1993 and recaptured on 30 November 1994, approx. 3.8 km upstream from the original nest site. The recapture site was 0.1 km upstream from an area known locally as the "Croc Hole" (near 144° 20' W, 17° 45' S). The crocodile was initially resting on a sandy bank, entered the water and was then caught within a shallow pool. It was emaciated and its length (19.7 cm snout-vent length) and mass (120 g) were below average in comparison to conspecifics of the same age (mean length = 23.5 cm, SD = 3.2 cm, $n = 100$; mean mass = 260 g, SD = 110 g, $n = 92$). From the crocodile's neck, I removed a nymphal tick which was placed into a vial of ethanol. The tick was identified at the Department of Parasitology, University of Queensland and the specimen deposited in the Queensland Museum (QMS26190, U.Q. Parasitology reference B398). Given the limitations of existing taxonomic keys, it is difficult to positively identify any nymphal tick beyond the genus level. However, the distribution records for tick specimens in the Queensland Museum strongly suggest either *Amb. limbatum* or *Amb. moreletae*.

No ticks are known to be obligate ectoparasites of crocodiles (J. Keirans, pers. comm.) and there are few published records of ticks found on crocodiles. Neuman (1899) recorded *Amblyomma* ? *grossum* (Pallas) on crocodiles in Sumatra but the identity of the tick is questionable. *Aponomma exornatum* have been recorded on a crocodile (probably *C. niloticus*) in the Congo (Schwetz, 1927), on *C. niloticus* in Uganda (Mathysse & Colbo, 1987) and in Mali (Villiers, 1955). These records likely resulted from a crocodile preying upon a tick-infested animal or by transfer of a tick from another reptilian host. The latter source is more probably given the high frequency of tick infestations recorded on *Varanus niloticus* from the same regions in Africa.

Over 100 species of *Amblyomma* exist worldwide and the life histories of well known species indicate they are three-host ticks (Roberts, 1970). Six Australian ticks are common ectoparasites of reptiles (*Amb. albulum*, *Amb. moreletae*, *Amb. limbatum*, *Amb. calabar*, *Ap. fribianum* and *Ap. hydraurum*) (Roberts, 1970; Heatwole & Pianka, 1993) and a complete host-parasite list appears in Roberts (1970). Two newly described species, *Amb. glauerti* and *Ap. glebopalma*, were added recently for varanid lizards (Keirans et al., 1994). Although a few semi-aquatic hosts have been recorded, including two chelid turtles and a water dragon, reptilian hosts of ticks are predominantly from arid terrestrial habitats.

Distribution records of reptilian hosts for this tick genus (Queensland Museum, unpubl. data) include many large snakes and lizards with ranges that overlap the study site, particularly Eastern brown snakes (*Pseudonaja textilis*), carpet pythons (*Morelia spilota variegata*), and sand goannas (*V. Gouldi*; Cogger, 1992), although other undocumented hosts cannot be excluded. Goanna tracks are common on the sandy flood plain at the study site and their trails cross the river near the capture location (A. Tucker, pers. obs.). Although previous herpetofaunal surveys of this region indicated a decline in their numbers (QDEH, unpubl. data), recent observations confirm that goannas are at least locally abundant near Frenchy's Crossing (0.7 km upstream of the recapture loca-

tion). It cannot be verified that the tick was transferred from these or other potential hosts but the tick certainly attached during a terrestrial emergence by the crocodile, as hard ticks do not occur on wholly aquatic vertebrates. Freshwater crocodiles emerge mainly to bask, or nest, but sometimes move overland during the dry season. Parasite transfer by ingestion of a tick-infested host is unlikely as the diet of yearling *C. johnstoni* includes no vertebrates other than tiny frogs. This host-parasite relationship is undoubtedly rare since this represents the only occurrence noted in over 3300 crocodiles examined individually for ectoparasites during the study.

Although the evidence is circumstantial, it appears likely that a local goanna population serves as a preferred host for the tick. Large lizards can easily serve as potential vectors since tropical teals or varanids are commonly parasitised by ticks and often found near habitats used by crocodilians. It is reasonable to presume that tick-parasitism of crocodiles probably resulted from indirect transfer from a reptilian host rather than through direct ingestion of parasitised prey. In either case, the occurrence of tick parasitism on crocodiles remains highly infrequent.

Acknowledgements

I thank B. Scott for tick identification; T. Jessop and T. Dempster for field assistance; J. Keirans for references; C. Limpus and H. McCallum for constructive comments, and H. Janetski and M. Bull for records of reptile or tick distributions.

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A NEW *CTENOTUS* (REPTILIA: SCINCIDAE) FROM THE MITCHELL GRASS PLAINS OF CENTRAL QUEENSLAND

STEPHEN K. WILSON AND PATRICK J. COUPER

Stephen K. Wilson & Patrick J. Couper 1995 12 01: A new *Ctenotus* (Reptilia: Scincidae). *C. agrestis* from the Mitchell Grass plains of central Queensland. *Memoirs of the Queensland Museum* 38(2):687-690. Brisbane. ISSN 0079-8835.

Ctenotus agrestis sp. nov., from the black soil, grassland plains of the Aramac area of central Queensland, is a member of the *C. lesueurii* group. It bears some resemblance to *C. robustus* and *C. joanae*. Colour, pattern and scalation readily distinguish it from these species.

□ *Ctenotus*, *C. lesueurii* group, black-soil, central Queensland.

Stephen K. Wilson & Patrick J. Couper, Queensland Museum, PO Box 3300, South Brisbane, Queensland 4101, Australia; 14 June 1995.

Ctenotus is the largest genus of Australian reptiles. Ninety species are now recognised. Diversity is greatest in arid and seasonally dry areas, yet few *Ctenotus* inhabit the deeply cracking clay (= "black-soil") plains with Mitchell grass (*Astrebla*) of Australia's eastern interior. During a herpetological survey in central Queensland (1987), three specimens of a new *Ctenotus*, conforming to the *C. lesueurii* species group of Storr et al., 1981 (toes only slightly compressed, lamellae under toes with a wide callus; second supracocular wider than third; pattern well developed with bold dorsal stripes and pale lateral spots) were collected from grasslands near Aramac.

While many reptiles (e.g., *Ctenotus robustus*) include black-soil plains in their broad distributions, only a small number appear to be confined to this distinct habitat. *C. agrestis* joins a short list of species (*Pogona henrylawsoni* (Agamidae), *Ctenotus schevilli* and *C. joanae* (Scincidae), *Varanus spenceri* (Varanidae), *Pseudechis colleti*, *Pseudonaja guttata* and *P. ingrami* (Elapidae) regarded as black-soil endemics.

All measurements were taken using Mitutoyo electronic callipers. Supraciliaries, supralabials, infralabials and subdigital lamellae on the fourth toe were counted on both sides of specimens examined. Abbreviations for body measurements are as follows:- snout-vent length (SVL); axilla to groin (AG); tail length, vent to tip (TL); forelimb, axilla to tip of longest digit (L1); hindlimb, groin to tip of longest digit (L2); forelimb to snout, from anterior limb insertion to tip of snout (L1-S); head width, widest point (HW); head length, tip of snout to posterior margin of parietals (HL); snout, tip to anterior margin of orbit (S); eye to ear, posterior margin of orbit to dorsal anterior margin of ear (EE). Additional material examined in this study is listed in appendices 1 &

2. Other abbreviations used: Queensland Museum (QM), Australian Museum (AM), Museum and Art Gallery of the Northern Territory (NTM).

SYSTEMATICS

Ctenotus agrestis sp. nov.
(Figs 1, 2)

Ctenotus sp. (2). Wilson & Knowles, 1988, p.277.

MATERIAL EXAMINED

HOLOTYPE: QMJ46694, Brendallan Stn, via Aramac, central Queensland (22°57'S, 145°14'E), coll. S.K. Wilson and P. J. Couper, 06 March 1987. PARATYPES: QMJ46689, QMJ46695, collection data as for holotype except QMJ46689, coll. 05 March 1987.

DIAGNOSIS

Ctenotus agrestis can be confused only with *C. robustus* and, to a lesser degree, with *C. joanae*. It is readily distinguished from the former by its pale colour (dorsally pale grey-brown vs brown-olive brown); size (max SVL 73.9 vs 110.0mm); size and shape of ear lobules (inconspicuous and rounded versus prominent, and pointed or rounded); single supradigital scale row on the fourth toe (extending along entire digit vs distal portion of digit only, fig.3).

From *C. joanae* it is distinguished by the number of scales along the mid-line between the mental and anal scales (77-78 vs 63-68); and by the upper lateral pattern (elongate pale dashes versus plain, or sometimes with a series of small pale dots).

DESCRIPTION

SVL(mm) 66.5-73.9 (mean=71.2, N=3). Proportions, (%SVL):- AG=49.2-53.3 (mean=51.2, N3); TL=155.4-173.2 (mean=164.3, N=2);



FIG. 1. *Ctenotus agrestis* sp. nov., (Holotype QMJ46694) in life (Photograph by S. Wilson).

L1=24.8-29.2 (mean=26.9, N=3); L2=37.6-41.5 (mean=39.9, N=3); L1-S=33.1-33.4 (mean=33.2, N=3); HW=12.9-13.0 (mean=12.96, N=3); HL=16.5-18.1 (mean=17.6, N=3); S=7.3-8.3 (mean=7.9, N=3); EE=6.8-7.8 (mean=7.3, N=3).

Nasals in point to broad contact; nasal groove absent; prefrontals very narrowly to moderately separated; maximum length of frontal 1.7-2.1 times maximum width (mean=1.9, N=3); frontal contacting frontonasal, prefrontals, first three supraoculars and frontoparietals; supraoculars 4, second the largest; supraciliaries 7-8 (mean=7.5, N=6), first or second the largest; frontoparietals paired and distinct from interparietal; enlarged nuchals 7-9 (mean=8, N=3), two-three in direct contact with parietals; loreals two; presuboculars 1; preoculars 2, the lower being the largest; supralabials 7-8 (mean=7.5, N=6) with fifth or sixth subocular; infralabials 6-8 (mean=7, N=6); postmental contacting two infralabials on each side; ear opening large, vertically elliptic with 3-4 (mean 3.2, N 6) small lobules on anterior edge.

Midbody scale rows 30-32 (mean=30.7, N=3); number of scales in a direct line between mental and anal shields 77-78 (mean=77.7, N=3); paravertebral scales, from anterior-most nuchal to posterior margin of hindlimb 60-61 (mean=60.7, N=3); lamellae beneath fourth toe

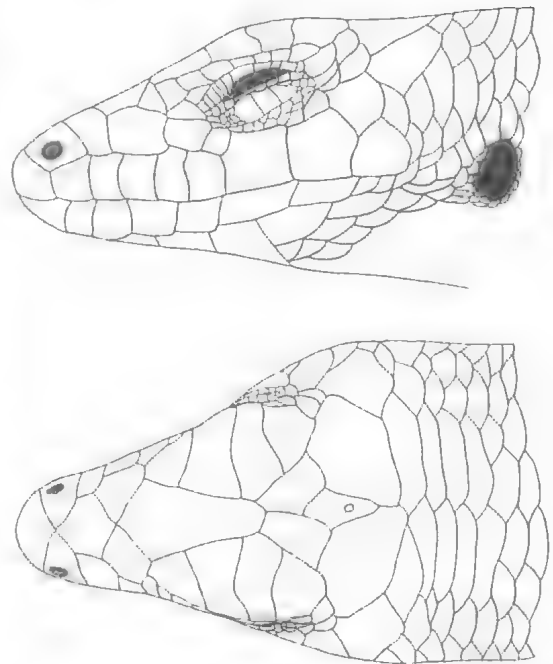


FIG. 2. *Ctenotus agrestis* sp. nov., Holotype QMJ46694. Lateral and dorsal views of head.

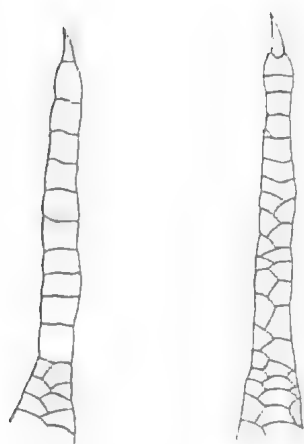


FIG. 3. Arrangement of supradigital scales on the fourth toe. (Left) *Ctenotus agrestis* sp. nov., Holotype QMJ46694. (Right) *Ctenotus robustus*, AMR62272.

17-19 (mean=18, N=6) broadly callose; a single row of supradigital scales present along almost the entire length of the fourth toe.

The measurements and scale counts for the holotype (QMJ46694) are as follows: SVL=73.3mm; AG=36.1mm; TL=114.0mm; L1=18.2mm; L2=27.5mm; L1-S=24.29mm; HW=9.5mm; HL=12.1mm; S=5.4mm; EE=5.0mm. Maximum length of frontal 4.9mm; maximum width of frontal 2.4mm; supraciliaries 8, first largest; enlarged nuchals 9, three in direct contact with parietals; supralabials 8 (left side) with sixth entering eye, 7 (right side) with fifth entering eye; infralabials 7 (both sides); ear lobules 4 (left side) 3 (right side); midbody scale rows 30; number of scales in a direct line between

mental and anal shields 77; paravertebral scales 61; lamellae beneath fourth toe 17 (left side) 18 (right side).

Pattern. Holotype - Dorsal and upper lateral ground colour pale-grey brown. Longitudinal stripes (Fig. 1) are as follows: Vertebral black, broad and prominent, from nuchals to base of tail; paravertebrals diffuse and pale; dorsolateral white, from above eye to tail tip, bordered dorsally by irregular black edge; upperlateral, a series of pale grey dashes, from eye to hindlimb; midlateral white, from nostril to tail; lowerlateral obscure grey-brown, from labials to tail; ventrolateral grey-brown, incomplete, between axilla and hindlimb. Ventral surface white. Head with obscure dark blotches. Limbs pale grey-brown with pale stripes.

Variation in paratypes - Vertebral narrow and obscure (QMJ46695). Irregular black upper edge to dorsolateral, almost non-existent (QMJ46695). Ventrolateral continuous (QMJ46689).

DISTRIBUTION

Known only from Brendallan Stn (22°57'S, 145°14'E), via Aramac, central Qld.

HABITAT

(Fig. 4) The type and only known locality is an open black-soil plain vegetated with Mitchell Grass (*Astrebla* sp.) and scattered low Acacias (probably *A. farnesiana*).

ETYMOLOGY

Latin - *agrestis* relating to the fields, alluding to the open, grassland habitat at the type locality.

ACKNOWLEDGEMENTS

We thank the Landers family for kindly allowing us to work on Brendallan Station; Ross Sadlier and Paul Horner for allowing us access to specimens in the collections of the Australian Museum and Museum and Art Gallery of the Northern Territory respectively; Gordon Guymner from the Queensland Herbarium for identifying the flora in the habitat photograph; Lauren Keim for her assistance in the laboratory; Greg Czechura and Glen Ingram for their encouragement and advice; Jeanette Covacevich for suggesting improvements to the manuscript.

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FIG. 4. Habitat of *Ctenotus agrestis*, Brendallan Stn, via Aramac, Central Queensland (22°57'S, 145°14'E).

(University of Western Australia Press with Western Australian Museum: Perth).

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APPENDIX 1. Specimens of *Ctenotus robustus* examined in the current study. All localities are for Queensland unless otherwise indicated.

Queensland Museum. QMJ12110, Mt Molloy (16°41'S, 145°20'E); QMJ1686, Herbert Gorge (18°14'S, 145°32'E); QMJ27697, Hencamp Ck, 5km N, 1km E Rollingstone (19°02'S, 146°19'E); QMJ27646-47, Rowes Bay, 3km N, 3km W Townsville (19°14'S, 146°47'E); QMJ44567, Lolworth Stn., Blossom Hill (20°09'S, 144°59'E); QMJ44572, Lolworth Stn. (20°12'S, 144°58'E); QMJ5637, Lindeman Is. (20°27'S, 149°02'E); QMJ44586-87, Campaspe Stn (20°30'S, 145°38'E); QMJ44706, Mt Cooper Stn. (20°30'S, 146°51'E); QMJ44622-23, Helenslee Stn. (20°31'S, 145°42'E); QMJ44588-89, Pajingo Stn. (20°46'S, 146°10'E); QMJ44850, Hanging Rock Stn. (21°09'S, 146°47'E); QMJ44562-63, Natal Downs, Curtis Dam (21°11'S, 146°04'E); QMJ28332, Kynuna, 9.6km SE (21°40'S, 141°59'E); QMJ31526, QMJ31530, near Mt Flinders (22°33'S, 150°46'E); QMJ46682-83, QMJ46688, QMJ46693, Brendallan Stn via Aramac (22°57'S, 145°14'E); QMJ47152, Nth Keppel Is (23°10'S, 150°58'E); QMJ32586, 'Lochnagar', via Barcaldine (23°34'S, 145°39'E); QMJ46760, Kalapa (23°31'S, 150°16'E); QMJ24218, Curtis Is., S end (23°45'S, 151°18'E); QMJ27911, Lowmead, Warro (24°32'S, 151°45'E); QMJ47093, Dawson R. Crossing at Baroondah Stn (25°41'S, 149°13'E); QMJ12105, 17.6km from Goomeri (26°02'S, 152°02'E); QMJ31520, Sandy Ck, via Ferndale (26°45'S, 151°03'E); QMJ28625, Moreton Is., NE end (27°11'S, 153°24'E); QMJ22966, Virginia, Brisbane (27°23'S, 153°09'E); QMJ40741, Brisbane (27°28'S, 153°01'E); QMJ6747, Toowoomba (27°34'S, 151°57'E); QMJ16087, Forest Hill (27°35'S, 152°21'E); QMJ26384, Dynevor Lakes, 44.5km E, 7km N Thargomindah (28°04'S, 144°10'E); QMJ35407, QMJ35427, Inglewood, old dump site (28°25'S, 151°05'E); QMJ35426, Brush Ck Stn, 21km S Inglewood (28°36'S, 151°06'E); QMJ40359, Ballandean, via Stanthorpe (28°48'S, 151°50'E); QMJ47095, Girraween NP via Stanthorpe (28°50'S, 151°55'E); QMJ12113, Wyberba, via Stanthorpe (28°52'S, 151°52'E); QMJ30720, Texas Caves, via Texas (28°53'S, 151°26'E); J439, S Queensland; QMJ31860-01, Condobolin, NSW (33°05'S, 147°09'E).

Australian Museum. AMR62275, 143km S Hughenden (22°00'S, 144°28'E); AMR64334-35, 80.1km N Muttaborra via Hughenden rd. (22°02'S, 149°29'E); AMR61500-13, 150km from Hughenden on Muttaborra rd. (22°13'S, 144°16'E); AMR62271-72, 38km S of Muttaborra on Aramac rd. (22°46'S, 144°53'E); AMR62274, 64km S Muttaborra on Aramac rd. (22°51'S, 145°04'E); AMR62273, Aramac rubbish tip (22°58'S, 145°14'E).

APPENDIX 2. Specimens of *Ctenotus joanne* examined in the current study. All localities are for the Northern Territory unless otherwise indicated.

Queensland Museum. QMJ54383-84, vicinity of Widdallion Ck: NWQLD (18°26'S, 138°29'E).

Australian Museum. AMR71363, Avon Downs (20°02'S, 137°30'E); AMR80360-61, AMR80531, 20km W of QLD/NT border on Barkly Hwy, (19°58'S, 137°49'E).

Museum and Art Gallery of the Northern Territory. NTMR3636, Anthony Lagoon (19°59'S, 135°36'E); NTMR5326, Anthony Lagoon (17°59'S, 135°32'E); NTMR8447, No. 6 bore, Rockhampton Downs (19°23'S, 135°24'E); NTMR9573, No. 17 bore, Alroy Downs (19°06'S, 136°12'E); NTMR14628, Rocklands Stn., Barwidgee Ck (19°49'S, 137°55'E); NTMR16424, Brunette Downs, Racecourse (18°36'S, 136°06'E).

FIRST ENDEMIC AUSTRALIAN OECOBIIDAE AND NESTICIDAE (ARACHNIDA: ARANEAE)

JÖRG WUNDERLICH

Wunderlich, J. 1995 12 01. First endemic Australian Oecobiidae and Nesticidae (Arachnida: Araneae). *Memoirs of the Queensland Museum* 38(2): 691-692. Brisbane. ISSN 0079-8835.

Oecobius inopinatus sp. nov. and *Nesticella chillagoensis* sp. nov. are described from Queensland, and represent the first endemic Australian species of the Oecobiidae and Nesticidae respectively. Both taxa are only known from females. □ Araneae, Nesticidae, Oecobiidae, taxonomy, Australia.

J. Wunderlich, Hindenburgstr. 94, D-75334 Straubenhardt, Germany; 1 September 1995.

Until now, no endemic species of Oecobiidae and Nesticidae have been described from Australia. It has not been discussed whether members of these families never reached Australia to evolve native species or whether such species are extinct. These records show that there are indeed endemics of these families in Australia: on the bark of trees (Oecobiidae) and in caves (Nesticidae). Such places are not well studied, so these - and perhaps some more related and unrelated - species have been overlooked.

Family OECOBIIDAE

AUSTRALIAN SPECIES

Oecobius navus Blackwall, 1859, (= *annulipes* auct.) cosmopolitan; *Oecobius inopinatus* sp. nov.

Oecobius inopinatus sp. nov. (Fig. 1)

MATERIAL EXAMINED

HOLOTYPE: QMS26040, ♀, near Rockhampton, E Queensland, no exact location, on bark of trees. Coll. J. Wunderlich. July, 1992.

PARATYPES: QMS26041, 2♀, 1 juv. same data.

DIAGNOSIS

Female prosoma medially largely black (Fig. 1A), epigyne/vulva (Fig. 1B,C) with small circular hole frontally which bears genital openings, medially with strongly concave sclerotized structure, posteriorly with fissure; with large and thin-walled receptacula seminis. Male unknown.

ETYMOLOGY

Inopinatus meaning unexpected.

DESCRIPTION

Measurements (mm): body 1.8-2.0 long, prosoma: 0.6 long, 0.7 wide, leg I: femur 0.52, patella

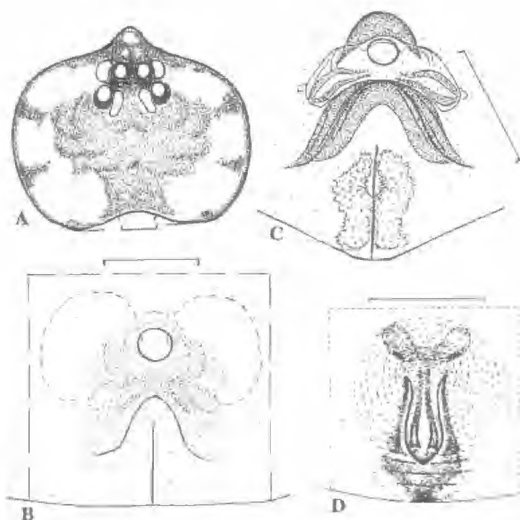


FIG. 1. A-C, *Oecobius inopinatus* sp. nov.: A, prosoma dorsally. B, epigyne. C, vulva dorsally (receptacula not shown). D, *Oecobius navus* Blackwall, 1859, epigyne. Scale = 0.1mm.

0.2, tibia 0.4, metatarsus 0.38, tarsus 0.35, tibiae II-IV 0.4.

Colour of sternum yellow, prosoma dorsally yellow, marginally and largely medially black (Fig. 1A), chelicerae frontally with black spot, legs yellow with distinct black annulations, opisthosoma yellow to grey, dorsally with white and dark grey spots, laterally with dark spots, venter uniformly yellow, spinnerets yellow, posterior ones dorsally darkened.

Prosoma (Fig. 1A) wider than long, with large eyes, posterior median eyes reniform. Cribellum and calamistrum of normal size. Legs with some long bristles (most bristles broken off), longest under tarsus IV. Op-

isthosoma ovally, dorsoventrally depressed, covered with short hairs.

RELATIONSHIPS

This species differs from other known species in the unique conformation of the ♀ genitalia.

ECOLOGY & DISTRIBUTION

The spiders were found on the bark of trees near Rockhampton, Queensland.

Family NESTICIDAE
Nesticella chillagoensis sp. nov.
(Fig. 2)

MATERIAL EXAMINED

HOLOTYPE: QMS20910, ♀, deep inside Royal Arch Cave, e.g. entrance of St Bernard, humid places under stress, near Chillagoe NEQ. Coll. D. Flett & J. Wunderlich, July 1992.

DIAGNOSIS

Female colour pale, legs with long hairs, eyes of medium size (posterior margin of posterior median eye lenses indistinct, Fig. 2A), epigyne (Fig. 2B) slightly sclerotized, ducts and receptacula seminis clearly visible; vulva (Fig. 2C). Male unknown.

DESCRIPTION

Measurements (mm): body 2.8 long, prosoma: 1.3 long, 1.15 wide, leg I: femur 2.0, patella 0.6, tibia 1.95, metatarsus 1.95, tarsus 0.8, tibia II 1.5, tibia III 1.0, tibia IV 1.7, length of some hairs: on tibia I 0.35, on the opisthosoma dorsally 0.33.

Colour pale, prosoma and legs orange, opisthosoma medium grey. Prosoma wide, with large and low grove.

Eyes (Fig. 2A) of only medium size, posterior margin of posterior median eye lenses indistinct, posterior row straight, posterior median eyes separated by slightly more than their diameter. Chelicerae large, anterior margin with 3 large teeth, posterior margin with some tiny teeth and with tiny teeth in the furrow. Labium fused to sternum, wider than long, claw of pedipalpus long, slightly bent, with numerous long teeth. - Legs of medium length, covered with long hairs, tibiae with two hair-shaped bristles(?). All metatarsi with a trichobothrium, its position on I in

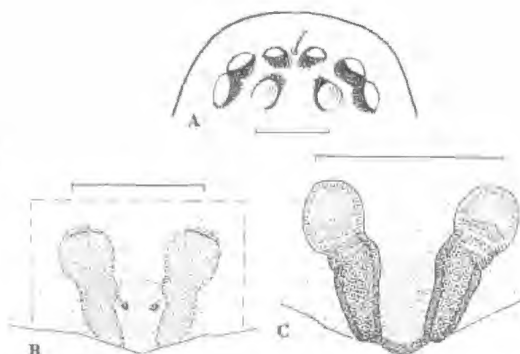


FIG. 2, A-C, *Nesticella chillagoensis* sp. nov. A, eyes dorsally. B, epigyne. C, vulva dorsally. Scale=0.2mm.

0.43. Opisthosoma ovally, dorsally covered with long hairs, colulus basally with a couple of hairs.

RELATIONSHIPS

I do not know a closely related species. This species is distinguished by the unique conformation of the female genitalia. Only few *Nesticella* species from New Guinea have been described, compare e.g. Lehtinen & Saaristo (1980). A new *Nesticella* species from north Queensland was hinted in Davies (1986: 47, fig. 76) (♂). In this epigeic (?) species, the posterior median eyes are not reduced. It is a pity that we do not know its male.

ECOLOGY & DISTRIBUTION

Considering the cave locality in north Queensland, Australia, the pale body colour and the slightly reduced posterior median eyes, the spiders seem to be trogloditic.

ACKNOWLEDGEMENTS

I am grateful to the Deutsche Forschungsgemeinschaft (DFG) who supported this work.

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